THE

PRACTITIONER'S GUIDE

TO

URINARY ANALYSIS

BY

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PREFACE TO SECOND EDITION.

THE reception given to the first edition of the "GUIDE" has been such as to encourage the author to make a thorough revision of the work, the results of which are now to be seen in the present volume.

Within the past ten years there has been a noteworthy increase in interest, on the part of the medical profession, in the subject of urinary analysis; the value of chemical and microscopical examinations of the urine has come to be realized; the clinical significance of the various constituents, normal and abnormal, of sediments, etc., is better understood now than ever before by the rank and file of the profession; knowledge, which in the misty past was possessed only by the specialist, is now part of the routine training of junior students. I can distinctly remember the time when almost the entire course in urinary analysis consisted of the rather bungling detection of *albumen*, as it was called, and of sugar. In those palmy days, "albumen" in the urine signified "Bright's disease" and sugar "Diabetes." Often a high specific gravity, say 1030, was proof positive of the presence of sugar, rendering chemical tests unnecessary! Many a remedy won laurels wholly undeserved, no doubt, in curing diseases which never existed.

At the present time, the merest tyro is taught not

only how to detect albumin and sugar, but also how to estimate the daily quantity of urea; to collect and measure the urine of 24 hours; to calculate the amount of solids; to test the sediment chemically, and to identify its constituents with the microscope. The number of really fine microscopical instruments owned by medical students is now something surprising and gratifying. Many men become comparatively expert in the use of the microscope long before graduating, and preserve, by mounting, valuable specimens of urinary sediments obtained at clinics. I am greatly in hopes that this practice of collecting "slides" during the medical college course will become a favorite one with students. It is in great contrast to the apathy formerly so marked, and which almost every teacher of chemistry or microscopy had to contend with. An important factor in modern diagnosis through examination of the urine is knowledge of the entire quantity in 24 hours. It is to Prof. E. S. Wood of Harvard College that we are indebted for beginning the agitation of this subject. In the paper written by him some years ago and quoted in this book, he expresses regret that so little attention is paid to the collection of the 24 hours' urine. For my part I have had fairly good fortune in this respect with such cases as have been brought to me of late years. In a majority of instances the attending physician has been able to procure the total quantity passed in twenty-four hours, and, as a consequence, I have been able to calculate the total amount of solids, estimate the quantity of urea and of other constituents and give the patient an opinion which, if based merely on examination of a single specimen, would have been of comparatively little value. Dr. Oliver of England has called our attention to the importance of several other points in the diagnosis of kidney diseases, viz.: the amount of urine passed at night

as compared with that of the day, and the specific gravity after digestion of food taken at meals; the presence of a small quantity of albumin in the urine of women due to purulent contamination has also been noticed by him. Modern science and observation have taught us that a pregnant woman may void urine containing albumin but nephritis not necessarily exist; but that the coming of convulsions is *always* preceded by marked falling off in the total quantity of the twenty-four hours' urine. Ralfe, by means of his admirable books, has shown us again and again the value of examination of the urine as a means of diagnosis; the distinctions that he points out between functional and organic albuminuria are worthy of the study of every practitioner. The investigations of such men as the German Senator and the Italian Semmola have done much for us, also, in clearing away the fog which lay heavy over the causes and significance of albuminuria.

Dr. F. R. Cruise. of Dublin, has kindly sent me his paper on "Quantitative Estimation of Albumin, Sugar and Urea," extracts from which will be found here and there throughout this work. At Contrexéville, where Dr. Debout d'Estrées makes numerous estimates daily, the Esbach processes for urea and albumin are used and the Laurent polarizing saccharimeter for sugar. It is to be regretted that the expense of the polarizing instruments is such as to make them practically inaccessible to many practitioners.

With regard to the innumerable tests for albumin which have sprung up of late years, I have taken the following ground:

1. That a thing which is *new* is not necessarily more valuable because of its newness than a thing which is old: for example, pumping gases into rectums.

2. That on the other hand, a thing which is new is not essentially *worthless* because of its newness.

I have endeavored, therefore, on the one hand, to avoid swallowing a bait merely because it is fresh—a fault common to younger members of a profession, and on the other hand not to scorn and trample upon a new flower in my urinary garden merely because I am well pleased with my older exotics. Disentangled from metaphor, then, my position on the subject of the newer tests is the following:

I am willing to accept and to recommend any test which I find from personal experience is sufficiently accurate in its results for clinical purposes, and, at the same time, such that the average practitioner can manage the manipulation required in performing it. A test which is brilliant, satisfactory and successful in the hands of an Oliver, a Johnson, or a Ralfe, may be a flat failure as performed by Smith, Jones or Robinson. From personal experience in teaching some hundreds of medical students I have felt inclined to adhere to the Heller test for albumin, supplemented by the heat test. The committee appointed in Great Britain to disentangle the snarl of albumin tests reported in favor of heat and nitric acid. Dr. Penzoldt of Germany gives precedence to citric acid and potassium ferrocyanide, but thinks the heat and nitric acid test next best. Tyson in this country has shown the heat test properly performed to be very delicate. My own experience coincides with the authorities just named, and accordingly the "busy" practitioner will turn over these pages in vain, and spend his valuable time to no purpose if he expects to find lengthy descriptions of everybody's latest "fad" in albumin testing. If he craves something which is distinctly new, and, so far as I know, described in no other book on

Urinary Analysis, I will refer him to the description which I give of an apparatus of my own design for the better performing of the Heller test for albumin.

In general terms, however, I will warn the general practitioner against anything and everything in urine testing which is "new" and untried. Many "tests" are devised for the purpose of advertising certain firms, or of creating a demand for certain chemicals and certain apparatus; the brilliant and "original" articles which appear in the journals are too often merely advertisements insidiously worded and inserted for purposes, directly or indirectly, of gain. The physician, for fear of not being "well-posted" or "up to date," is many times driven to try tests which, for his purpose, are entirely worthless and misleading.

The object of this book is to give as much information as possible in a few words. That part of it which relates to chemical and microscopical work has been used by the author with his classes so often that all points likely to confuse or cause error have been noted and due warning given of them. It is hoped that nothing has been deemed so simple as not to be explained in the course of the book. The index to this edition is very full and the reader will find it to his advantage to consult it often. Many new points with reference to diagnosis have been inserted, gleaned from the papers of the specialists on kidney diseases and allied complaints, and confirmed by the author's own experience. It is hoped that by study of the sections on "clinical significance" the general practitioner will feel emboldened to make closer diagnoses than were attempted in bygone days. That there is great room for study and improvement in this direction, nobody will deny who has paid any attention to cases in which examinations of the urine are made. While in many cases it is practically

impossible to arrive at a correct diagnosis, in others there is really no excuse for the absurdly incorrect opinions that are given the patient by those attending him. Unfortunately, also, the opinion which carries the most weight may many times be the furthest from the truth, as casual post-mortems will show. Just as Dr. Tanner, the author of "Memoranda of Poisons," was convinced of the frequency of secret poisoning, so the author of this little volume is convinced of the frequency of incorrect diagnosis. It is, however, very much to be regretted that the accuracy of an opinion can often only be proved by a post-mortem examination; and that the latter in a large number of cases can not be performed, owing to the unwillingness of relatives of the deceased. Hence it is that the practice of medicine is a field where often times the least worthy may succeed. It is highly necessary, therefore, for every practitioner who looks upon medicine as a science, and not merely as a trade, to inform himself so thoroughly on all points relating to diagnosis as to be able to hold his own with the "glittering generalizers" who rely on "odyllic" qualities alone for success.

CLIFFORD MITCHELL.

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THE

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INTRODUCTION.

Test-tubes.—Most of the work to be done in examining a specimen of urine requires some familiarity with the use of *test-tubes*—small glass cylinders closed at one end and open at the other. Test-

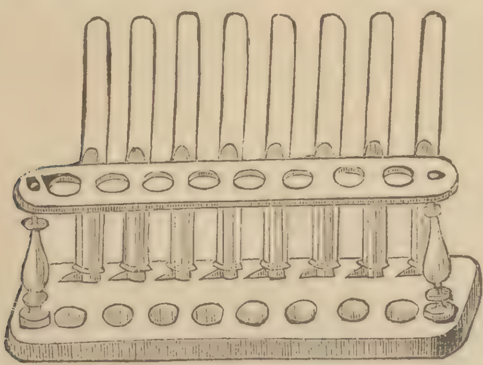

Fig. 1.

tubes holding one-half a fluid ounce are of convenient size in urine analysis; when filled with any liquid they should be stood in the apertures of a *test-tube rack* or *stand* (Fig. 1); when cleaned, a

test-tube brush should be used, which is merely two wires twisted together, holding at one end a number of bristles. Test-tubes are so called from the fact that in them "tests" are conveniently made; a specimen of urine is said to be "tested" for any substance it may contain when certain processes, chemical or physical, are gone through with, with a view to ascertain whether or not the substance be present in the urine. Thus a "test" is said to be made for albumin when the urine, supposed to contain it, is *heated*, or when nitric acid is added, etc.

After a test has been made the test-tube which has been used should at once be cleaned; if it be not convenient for any reason to do this the tube may stand in the rack until all work of the kind has been finished, when all the test-tubes which have been used may be cleaned at one time. It is not advisable to allow urine to remain in the tubes for any length of time, especially when to it have been added various reagents.

FIG. 2.

Never stand a test-tube in a cup, glass or beaker, but always in the rack.

To clean the tubes pour out the liquid contained in them, if any, rinse out with water, which if possible should be *warm*, then filling half or two-thirds full of water introduce the test-tube brush and work it to and fro carefully pushing it down to the very end of the tube. After the tubes have been washed they should be inverted over the pegs in the rack to dry.

Never use a dirty test-tube, and never perform more than one test at a time in one tube, unless particularly directed.

If the tubes cannot be thoroughly cleaned with water, try acids, ammonia, alcohol or ether.

How to heat or boil urine.—To heat urine fill the test-tube half-full and hold over an alcohol-lamp flame gently moving the tube from side to side so as to prevent boiling; when it is necessary to boil the urine, take a strip of paper, four or five inches long, and say, half an inch wide, fold it around the tube a little above the point corresponding to the surface of the liquid inside, press the two ends of the paper tightly together keeping the tips of the thumb and forefinger against that part of the paper which envelopes the tube, then hold the tube cautiously over the flame until it boils.

It is not desirable to use a gas flame for heating or boiling urine inasmuch as the test-tube becomes covered with soot and if the flame be too strong there is danger of cracking the tube unless it be kept actively in motion.

With an alcohol-lamp flame urine can be boiled for some time without bubbling over, if due care be exercised.

In testing urine always notice whether the directions given in the "Manual" used are *to heat* or *to boil*, and if the former is specified, remove the test-tube from the flame before the first sign of ebullition.

If any reagent to be boiled, as Fehling's solution, have a tendency to "bump," i. e., suddenly and without warning to boil over, add a few fragments of an ordinary clay-pipe which must be clean and new.

If boiling water is at hand urine may be heated by holding the test tube containing it in the water. It may be cooled by dipping into cold water.

In testing for albumin the urine should be boiled *in part* only; hold the tube by the closed end between

thumb and forefinger and heat the upper part of the column of urine.

Test-glasses.—Next in importance to test-tubes are the glasses in which urinary sediments are collected.

To collect a sediment or deposit, allow the urine to stand at rest in a tall, narrow, cylindrical glass vessel like the one shown in Fig. 2; the best are those provided with a lip. After the deposit has settled to the bottom of the test-glass, remove the clear urine by *decantation.*

To decant urine hold the test-glass very steadily in the right hand; against the lip hold with the left hand a glass rod, grasping the latter near its upper end.

Next incline the test-glass in such a way as to pour the urine down the rod into any vessel desired. Cease pouring at the moment any of the sediment is seen to slip out.

It is well to have one test-glass which is graduated either in centimetres or fluid ounces, large enough to hold four or five of the latter and provided with a foot or base.

Pipettes.—To examine a sediment with the microscope there is need of the little instrument called a *pipette*, which is (*a*) merely a slender glass tube six to twelve inches long with an internal diameter of from $\frac{1}{10}$ to $\frac{1}{20}$ inch and drawn out to a pointed end; the use of a pipette is to transfer a drop of urine containing sediment to the glass slide used in microscopical work. After the deposit has settled to the bottom of the test-glass, place the tip of the forefinger over the upper end of the pipette and dip the lower or pointed end into the sediment. Next remove the finger for an instant, then quickly close the orifice again with it. A portion of the sediment has passed into the pipette and can be held there so long as the finger is tightly pressed against the orifice in the

upper end of the pipette, hence can be carried to a glass slide, when,on removing the finger, the sediment will flow out.

The best pipette for collecting urinary sediments is (b) a glass tube, having a calibre of one inch in diameter and a length of ten or twelve inches; one extremity is tapered off to a very small orifice and furnished with a glass stop cock. The sediment having been obtained in a test-glass as before, decant the supernatant urine, then pour the sediment into pipette (b) and allow it to settle. Carefully open the stop cock and a drop of the densest part of the deposit may be received on a glass slide and examined by aid of the microscope.

It is much better to use pipette (b) than the kind mentioned first, although more expensive.

Filtration.—Before performing certain tests, as for albumin, sugar, etc., it is advisable that the urine be filtered; the apparatus essential to filtration is composed of a *funnel*, *filters* or *filter paper*, *a filter ring* and *stand* and a test-glass. Funnels are of glass and of various sizes; those three or four inches in diameter across the top are of convenient size. Filter paper is unsized and many varieties of it are manufactured; the so-called "Prat Dumas" French filter paper comes cut in circular form in packs of 100 filters each and is the best for the physician's use. Filters having a diameter of 7½ inches are of convenient size for the funnel mentioned above.

In order to filter, take one paper from the package of cut filters (or cut out from Swedish filter paper a circular piece of 7 or 8 inches in diameter), and fold exactly double. Then hold the paper in such a way that its longest axis is vertical and fold double again. A funnel shape is, in this way, given to the paper. As thus folded, set the filter into the funnel, pressing it well down so that it does not tend

to work out, open either the inside or outside of the "pouches" formed and pour the urine to be filtered into it, using the glass rod as in decantation. Set the funnel into the filtering-ring and place a test-glass or any glass vessel desired beneath the spout of the funnel. Observe whether the urine trickling through into the test-glass or beaker beneath the funnel be clear; if not, pour the urine in the funnel into the test-glass, take out the filter paper, throw it away and fit a new one. Next take a clean test-glass or beaker, place it beneath the spout of the funnel, and pour the urine now contained in the first test-glass or beaker into the funnel.

Chemical Examination of Sediment.—If it be desired to examine the sediment chemically, wait until the urine has completely filtered, remove the filter-paper, place it in a porcelain dish, make a small hole in it and wash the sediment through this hole by means of the *wash-bottle;* the latter is a flask or bottle closed with a twice perforated snugly-fitting stopper through which two glass tubes are passed, each bent above the cork, the one at an acute angle the other at an obtuse. When the bottle is filled with water, blowing through the obtuse-angled tube will force a stream of water with considerable violence through the acute-angled tube, and any precipitate or deposit adhering to the filter paper may be washed off. Ordinarily the physician need not have recourse to this method of obtaining a sediment as decantation of the supernatant urine will answer most purposes, leaving, as it does, the sediment at the bottom of the test-glass.

Glass Jars.—The physician should own a few half-gallon or gallon glass jars in which to collect the urine of a patient when the whole quantity for twenty-four hours is required; besides these it is convenient to have a cylindrical jar graduated in

Cubic centimetres or fluid ounces, capable of containing 1000 Cubic centimetres (a little over a quart —two pints two fluid ounces nearly). The patient having collected the urine of twenty-four hours in one of the half-gallon jars the physician can measure the amount by one of the graduated jars.

Miscellaneous.—Besides the instruments mentioned thus far it is desirable to have three pipettes graduated in 5, 10, and 20 Cubic centimetres, an alcohol lamp, three or four porcelain dishes of different sizes, a small *chemical* thermometer for taking the temperature of urine, three or four glass rods, a pair of small brass forceps, litmus paper, both red and blue, readily obtained in little books, and an urinometer and beaker (see Specific Gravity).

Chemical Reagents.—Chemicals used in testing the urine are called *reagents*, the chemical processes being known as *reactions*.

The following are useful in urinary analysis:

Nitric acid, chemically pure, kept away from light and in glass-stoppered bottle.

Hydrochloric acid, chemically pure, kept away from ammonia in glass-stoppered bottle.

Acetic acid of two kinds, (1) pure glacial and (2) dilute—one part glacial to four parts distilled water, in glass-stoppered bottle.

Sulphuric acid, chemically pure, colorless, in glass-stoppered bottle.

Nitric acid, commercial, containing nitrous acid, in glass-stoppered bottle.

Ammonia, one part by volume, strongest, to three parts distilled water.

Potassa, one part solid caustic potash to ten parts distilled water by weight.

Silver nitrate, one part crystals to ten parts distilled water by weight, kept from the light, in blackened bottle.

Barium chloride, solution of the same proportions as the silver nitrate.

Potassium ferrocyanide, solution of the same proportions as the silver nitrate.

Fehling's solution—described under sugar.

Chlorinated Soda, U. S. P.—preferably Squibb's.

Alcohol, 95 per cent.

Spirit of Turpentine.

Tincture of Guaiac.

Ammonium molybdate in solution.

Caustic Potash, in sticks, kept in a bottle whose stopper has been paraffined.

Distilled water in a glass-stoppered bottle holding one quart or more.

Condensed yeast, to be bought fresh whenever needed.

Chemical Terms.—*Add nitric acid, add ammonia*, etc. When the term "add" is used without specifying the amount, neither too much nor too little of the reagent should be added to the urine; if the test-tube be half full of urine, fifteen to thirty drops of the reagent may be used. It will often be specified just how much to add.

Alkali, Alkaline, Alkalinity.—An alkali is a compound substance very soluble in water, turning red litmus paper blue, and opposed in its properties to the characters of sour or acid substances. The alkali most familiar to every one is *ammonia* which from its well known tendency to evaporate is called a *volatile* alkali. Potash and soda are called on the other hand *fixed* alkalies. The urine is said to be *alkaline* when a piece of red litmus paper dipped into it is turned blue; in such a case an *alkali* of some sort is present in the urine and we speak of the *alkalinity* of the latter.

Acid, Acids, Acidity.—The sour substances called acids are of several varieties: *mineral* acids

are very corrosive, generally liquid in form and have a powerful action on the skin, clothing, etc. Those used in urinary analysis are nitric, hydrochloric and sulphuric. They are corrosive poisons. Stains caused by acids are best removed by ammonia; nitric acid stains, however, must be washed repeatedly with a concentrated solution of potassium permanganate, then with water. Remove the brown stain of the permanganate by an aqueous solution of sulphurous acid.

Vegetable acids are less corrosive than mineral acids, but are frequently poisonous; the most important acid of this class used in urinary work is acetic acid. An acid substance may be recognized by its power of *neutralizing* an alkali (either entirely or partly), that is, destroying the characteristic properties of the latter.

Acids turn blue litmus paper red and when the urine has this effect upon such paper it is said to be *acid*, and we speak of its *acidity*.

In case a strong mineral acid be accidentally taken internally, an alkali must be administered as an antidote such as dilute carbonate of soda, magnesia with milk or water, carbonate of lime, mixture of soda; if an alkali be swallowed by mistake, the antidote is an acid solution such as vinegar and water equal parts, lemon juice, or the like. The same substances may be used for external injuries from strong acids or alkalies as the case may be, alkalies for acid burns and acids for alkali burns.

Salts.—A salt is a compound substance containing an acid in combination with a base (the latter term being applied to any compound body capable of neutralizing an acid partly or entirely, as oxide of zinc, any of the alkalies, etc., etc.); a salt may also consist of a metal in combination with chlorine, bromine, iodine, etc., though, properly, the term *binary*

compound should then be used. It is not necessary that the practitioner trouble himself greatly about these definitions; in this book when we speak of calcium carbon*ate* we mean a salt of calcium containing carbon*ic* acid in combination, when of potassium nit*rite* a salt of potassium containing nit*rous* acid in combination, when of sodium chlor*ide* a salt of sodium containing chlor*ine*.

A solution of ammonia, soda, or potassa is often called solution of ammonium hydrate, sodium hydrate, etc.; in familiar language these may also be termed solution of caustic potash, solution of caustic soda, etc.

Precipitate.—When a reagent is added to urine and a cloudiness or turbidity ensues, some substance which heretofore has been dissolved in the urine appears and causes this cloudiness, the urine on addition of the reagent no longer being able to hold the substance dissolved, or else some new and insoluble substance being formed from a combination of the reagent with some constituent of the urine, a turbidity is seen. Thus if nitric acid be added to urine containing albumin the latter is seen in the form of a cloudiness or turbidity, since the acid has rendered the urine incapable of holding the albumin dissolved; similarly if silver nitrate be added to urine a dense turbidity is at once seen caused by the formation of silver phosphate and silver chloride, both of which salts are insoluble in urine. The technical term for the cloudiness or turbidity thus produced is "precipitate"; albumin may be said to be *precipitated* on adding nitric acid to urine, and silver chloride may be said to be precipitated on adding silver nitrate to the urine.

Microscope.—The microscopic examination of urine is by no means formidable. Urinary sediments containing crystals are easily recognized and

it is only in the case of tube casts, blood, pus, etc., that any great care or experience is necessary. Any achromatic microscope provided with "objectives" and "eye-glasses" giving a power of from 200 to 600

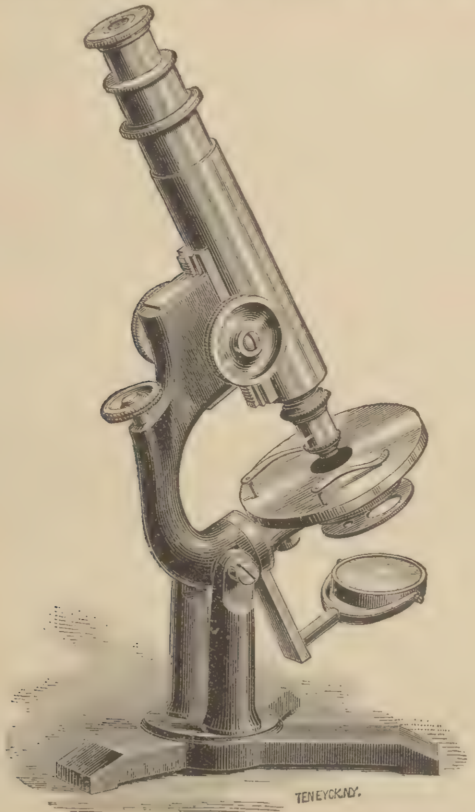

FIG. 3.

diameters will suffice; the so-called "students' microscopes," if from the hands of a good maker, are all that are required for urinary work.

The object to be examined is placed on a glass

"slide" or in a "cell" covered by a thin glass cover to keep out dust, etc.; and placed on the "stage"; by means of the "objective" (a lens placed on the lower part of the instrument near the object) and the "eye-glass" (a lens in the upper part near the eye), the magnifying power used may be determined as follows: if the magnifying power of the "objective" is 20 diameters and that of the "eye-glass" 10 diameters, 20x10 or 200 diameters is the total magnifying power of the microscope. Hence a number of different "objectives" and a number of different "eye pieces" will give a great variety of powers, but for urinary work two objectives are sufficient, namely, a "two-third inch" and a "one-fifth inch"; the "two-third inch" with different eye pieces will give a magnifying power of from 75 to 150 diameters, and the "one-fifth inch" 250 to 700 diameters; in case it be not convenient to obtain these, the one-half inch and one-fourth inch may be used. Physicians, not familiar with the technical terms used by opticians, in ordering a microscope for urinary work need only specify the kind of objectives mentioned above with eye-pieces necessary to produce a magnifying power of from 75 to 150 and 250 to 700 diameters. The microscope is so constructed that one "objective" can be taken out and another put in with but little loss of time.

The glass "slides" already mentioned are merely rectangular, flat pieces of glass upon which to place the objects to be examined; they should be kept scrupulously clean. The "covers" are of thin glass and are placed over the object when the latter is on the slide; they should not press against the object lest it be flattened or crushed. In most cases in examining sediments shallow glass or gum-dammar "cells" are better than "slides" since being hollowed in form they admit of a stratum of fluid of any degree

of thickness and the cover when placed is not so likely to press the objects.

Things Necessary for the Microscopical Examination of Urinary Deposits.—Microscope, two-third inch objective, one-fifth inch objective, several drop pipettes, any number of glass slides, thin shallow cells of glass or gum-dammar and thin glass covers, a flask of distilled water, a piece of old linen, a paste-board cover for the microscope, and a soft camel's hair pencil. The whole on a table having a couple of drawers and placed before a window. Arrange the microscope before a window whose aspect is opposite to the side on which the sun is shining. Obtain a good light at the left hand, then in examination of an urinary deposit proceed as follows: if you have the apparatus described under *pipette* (b.), and have done as described, turn the stop-cock and let a drop of the sediment fall on one of the shallow cells, cover it over with one of the thin glass covers and remove any urine which may exude at the margin of the cover with blotting paper; next place the cell under the microscope, manipulate the *mirror* so as to obtain proper light and examine with a *low power*, 75 to 150 diameters, first, as this enables you to see more of the deposit, focusing by turning the *movement* or *adjustment* gently until the eye is suited. In case the ordinary drop pipette is used close one end firmly with the forefinger and dip the tapering end down to the very bottom of the test-glass in which you have allowed the urine to settle, raise the forefinger a little so that about an inch of the pipette is filled with the sediment, close the finger over the aperture tightly, take out the pipette from the test-glass, cautiously loosen the finger a little so that about one-half the sediment drops out, close it again, wipe off the pipette with a piece of new linen or muslin held in the left hand, then gently

raise the finger so that a drop of the sediment falls on the shallow glass cell, when examine as before. This latter method of preparing a drop for examination is very troublesome and the physician will do well to obtain the instrument described under *pipette* (b), as it can be ordered of any dealer in chemical apparatus in the large cities; three or four pieces of india-rubber tubing fitted with glass jets are supplied with each instrument and these when not in use are to be kept in a bottle of dilute hydrochloric acid to prevent their becoming encrusted, being carefully rubbed dry before using.

The microscope can be kept in good order, etc., if (1) a pasteboard cover be placed over it each time after it has been used, if (2) strong acids like nitric and hydrochloric are not added to the objects on the slides or cells (acetic acid will answer in most cases), if (3) fumes of chlorine, ammonia and sulphuretted hydrogen do not take up their abode near it, if (4) any dust on the lenses be removed by the camel's hair pencil, if (5) spots or finger stains be gently rubbed off the lenses with a piece of moistened, soft old linen or kid glove, if (6) the surfaces be dried with dry, soft old linen, if (7) during cold or excessively damp weather the room be heated so that moisture may not form on the lenses, and if (8) nobody but the owner dust or wipe it. It is perhaps needless to remark that "objectives" should not be given to teething children wherewith to soothe their aching gums; various rubber appliances of much less cost will answer that purpose with less damage to both child and microscope.

If dust or moisture should have settled on the *mirror* it can readily be wiped off. If any spots should show themselves on the field of view when it is illuminated by the mirror these are probably due to particles adherent to one of the lenses of the eye-

piece; and this may be determined by turning the eye-piece round, which will cause the spots also to rotate, if their source lies in it. It may very probably be sufficient to wipe the upper surface of the eye-glass (by removing its cap), and the lower surface of the field-glass; but if, after this has been done, the spots should still present themselves, it will be necessary to unscrew the lenses from their sockets and to wipe their inner surface; taking care to screw them firmly into their place again, and not to confuse the lenses of different eye-pieces. Sometimes the eye-glass is obscured by dust of extreme fineness which may be carried off by a smart puff of breath; the vapor which then remains upon the surface being readily dissipated by rapidly moving the glass backward and forward a few times through the air. And it is always desirable to try this plan in the first instance; since, however soft the substance with which the glasses are wiped, their polish is impaired in the end by the too frequent repetition of the process. The best material for wiping glass is a piece of soft wash-leather, from which the dust it generally contains has been well beaten out. If the object-glasses (objectives) be carefully handled and kept in their boxes when not in use, they will not be likely to require cleansing. One of the chief dangers, however, to which they are liable in the hands of an inexperienced microscopist arises from the neglect of precaution in using them with fluids; which when allowed to come in contact with the surface of the outer glass should be wiped off as soon as possible. In screwing and unscrewing them, great care should be taken to keep the glasses at a distance from the surface of the hands; since they are liable not only to be soiled by actual contact, but to be dimmed by the vaporous exhalations from skin which they do not touch. This dimness will be best dissipated by

moving the glass quickly through the air. It will sometimes be found on holding an object-glass to the light that particles either of ordinary dust, or more often of the black coating of the interior of the microscrope have settled upon the surface of the back lens; these are best removed by a clean and dry camel's-hair pencil. If any cloudiness or dust should still present itself in an object glass, after its front and back surfaces have been carefully cleansed it may be unscrewed, cleansed, and screwed together again.—Carpenter.

If the microscope be used at night, a flat-wicked lamp fed with one of the best varieties of paraffine oil will prove the most useful light; place the lamp at the left hand so that no light, save that through the microscope may enter the eye.

Micro-Chemical Reagents.—The chemicals necessary for the identification of sediments described in this book are, acetic acid, ether, carmine solution, iodine water (one grain of iodine, three grains of iodide of potassium, one ounce of distilled water).

Acetic acid should be (1) concentrated, and (2) diluted with from three to five parts water; for some work the strong undiluted acid may be needed, but ordinarily the dilute is all that is necessary.

Carmine solution may be made in various ways. An ammoniacal solution is obtained by dissolving a few grains of pure carmine in a little ammonia and diluting with distilled water. Filter into a flask, and neutralize the solution with a few drops of acetic acid until it has only a very slight ammoniacal odor.

Drop-bottles to hold microscopical reagents are sold, and are very convenient, as they obviate the use of pipettes. The stopper is perforated and is elongated below into a fine tube which expands above into a bulbous funnel, the mouth of which is covered

with a piece of thin india rubber tied firmly round its lip. If pressure be made on this cover with the point of the finger and the end of the tube be immersed in the liquid in the bottle, this will rise into it on the removal of the finger; pressure of the finger on the cover will now expel the liquid.

How to Use Reagents.—When, in the course of an investigation, it is required to "add acetic acid," it may be quickly accomplished as follows: put a small drop of the sediment on the cell or slide (by either (a) or (b) under Pipettes), then dip a clean pipette into the bottle of acetic acid and carry a large drop of this reagent to the slide or cell where the drop of sediment is and add it to the latter, place a thin glass cover over it and examine with the microscope. Note carefully what is seen, remove the slide or cell from the stage, take a clean slide or cell, place on it a fresh drop of the sediment (to which *nothing* must be added), and examine with the microscope, observing what changes have been brought about by the addition of acetic acid, by comparing the sediment to which nothing has been added, with that to which acetic acid has been added.

If it is desired to note gradual changes on addition of a reagent, place a drop of sediment on a clean glass slide, and near it a drop of the reagent, put a thin glass cover over the drop of sediment and insert between the slide and cover a thread or pointed extremity of blotting or filter paper, and by capillary attraction a current will be established from the reagent to the sediment.

Metric Equivalents.—A *gramme.* in the French system of weights may be reckoned as fifteen and a half grains troy; accurately 15.434 grains. A *litre* corresponds to a U. S. quart—very nearly. It corresponds to 1,000 *Cubic Centimetres.*

URINARY ANALYSIS.

CHAPTER I.

PHYSICAL CHARACTERISTICS OF URINE.

In making an examination of urine, operations may be carried on in the following order: observe

1. Total quantity in twenty-four hours.
2. Color and appearance.
3. Odor.
4. Reaction.
5. Specific gravity.
6. Abnormal constituents—presence and quantity.
7. Quantity and appearance of deposit—chemical and microscopical characteristics.
8. Presence and quantity of normal constituents.

Quantity in twenty-four hours.—This may be collected by the patient in a clean glass jar, as described in the Introduction. If the jar be graduated in fluid ounces or Cubic centimetres, the amount passed can be read off very quickly and without the extra trouble of measuring in a separate vessel. The physician should always have some sort of a graduated glass jar for the purpose of measuring the twenty-four hours' urine collected by patients, since the latter are seldom provided with graduated apparatus of any kind; in case the patient be unable to procure a glass jar, any clean vessel capable of holding two quarts will answer the purpose, unless the patient be diabetic, when a much larger one may be

required. It is unquestionably a great aid to the physician to have the entire amount for twenty-four hours under examination, but when this cannot be obtained, examine the urine first passed on rising, or better, that passed three or four hours after the principal meal.

Color and Appearance.—Notice whether the urine when *filtered* be (1) pale, (2) normal, or (3) highly colored. If the urine contain no sediment its color may be readily observed without filtering, by pouring some into a cylindrical glass jar of not less than four or five inches in diameter, and observing it by transmitted light.

If the urine contain a sediment the latter must be removed by filtration before the color can be accurately determined, since a deposit will often be of such a color as, when in suspension in the urine, to affect the color of the latter; however, if a sediment be a heavy one (as when composed of urates) it may settle completely, and the color of the supernatant urine can be observed without the trouble of filtering.

Pale urine varies from colorless to straw-yellow; *normal*, from golden-yellow to amber; *highly-colored* from reddish-yellow to brown. Any unusual color of the urine, as green, black, blue, etc., should be carefully noticed and an explanation sought for in the section, headed "Color" under "Abnormal Urine."

In observing the color of urine, whether it contains a sediment or not will necessarily be also noticed; ascertain if possible whether the urine is (1) *turbid* when first passed, or (2) *clear* when first passed but turbid on cooling.

Odor.—The odor of urine may be either (1) its own—urinous, (2) sweetish, faint whey-like, or that of sour milk, (3) ammoniacal, (4) like rotten eggs —sulphureted hydrogen, (5) that of odoriferous

substances introduced into the organism, as asparagus, etc.

Reaction.—Ascertain whether the urine be (1) acid, (2) alkaline or (3) neutral, as follows: dip or drop two pieces of litmus paper, the one blue and the other red, into the urine, wait until they are entirely saturated and observe whether (1) both are *red*—reaction *acid*; (2) both are *blue*—reaction *alkaline*; (3) one is *red* and the other *blue*—reaction neutral.

If the reaction is found to be alkaline, take a slip of *red* paper, saturate it with the urine until it has turned entirely *blue*, then remove it and allow it to dry; observe whether after it is dry it be (1) yet blue or (2) red again.

Specific Gravity.—To estimate the specific gravity of urine it is well to use a specimen of the mixed urine of twenty-four hours, owing to variations in the specific gravity of urine voided at different times in the day. In ascertaining the specific gravity, the little instrument called the *urinometer* is used; this consists of a glass float weighted below with a bulb of mercury and having a stem graduated from 0 to 60 at intervals of two degrees, usually. The instrument should sink to the zero point when floated in distilled water. At 15 on the scale the letter H is usually printed to the right, and at 25 the letter S; the significance of these letters has been interpreted by some ingenious mind to be "healthy state," *i. e.*, if the urinometer sinks to some division on the scale between 15 and 25 the urine is "healthy." It is with great joy that I am able to announce confidently the true meaning of these mysterious abbreviations which on all well-regulated urinometers are now omitted. It is customary to call the zero point 1000 and other points 1014, 1020, etc., prefixing 10 to the numbers on the scale. Before using an urinometer

for the first time float it in distilled water of 60° F. temperature and if it does not sink to the zero point or 1000, reject it. In addition to the urinometer procure a glass cylinder or beaker to contain the urine whose specific gravity is to be taken; it is well to have a beaker of sufficient diameter to allow the urinometer to float gracefully without impinging against its sides. The beaker or cylinder should have a firm base so as not to be easily upset.

To take the specific gravity of a specimen of urine, fill the cylindrical vessel (Fig. 4) about two-thirds full, holding the cylinder obliquely while pouring the urine into it, thus avoiding as much as possible the formation of foam—if foam forms remove it with blotting paper. Next let the urinometer sink, bulb down, gently into the urine, being careful not to have it touch the sides of the cylinder. When it no longer sinks of its own accord, stoop down until the eye is on a level with the urine and read the number on the scale which is even with the *lower convex edge of the fluid, i. e.*, *not* the little elevation of liquid which by capillary attraction climbs up the stem of the urinometer a short distance, but the general surface of the urine. Depress the urinometer one degree, allow it to rise, and read again; if the second reading agrees with the first the figure is correct.

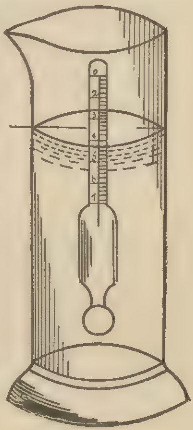

Fig. 4.

Specific gravity beads are now to be had, which in many ways are more convenient than the urinometer, especially for pocket cases.

Patients living at a distance have a debilitating habit of sending a fluidrachm or two of urine for examination as if it were worth ten dollars a drop

and they could not afford more. When a very small quantity of urine is thus furnished the specific gravity must be ascertained by dilution as follows: take *one* part of the urine and add *three* parts of distilled water to it so as to make enough liquid to fill the cylinder, say two-thirds full, and take the specific gravity as before with the urinometer. After obtaining the specific gravity multiply the last figure of it by 4, and the result is the specific gravity of the urine; thus if the specific gravity of the mixture be 1005, then multiply 5 by 4=20 and 1020 is the specific gravity of the urine itself. In other words, multiply the last figure of the specific gravity found by the total number of parts of urine and water.

Before taking the specific gravity of urine with an urinometer see whether the fluid has a temperature of 60° F. or not by dipping a chemical thermometer into it; if it has a temperature of about 60°, simply

Temperature.	No. to be added to the indication.	Temperature.	No. to be added to the indication.	Temperature.	No. to be added to the indication.
60°	0.00	69°	0.80	78°	1.70
61°	0.08	70°	0.90	79°	1.80
62°	0.16	71°	1.00	80°	1.90
63°	0.24	72°	1.10	81°	2.00
64°	0.32	73°	1.20	82°	2.10
65°	0.40	74°	1.30	83°	2.20
66°	0.50	75°	1.40	84°	2.30
67°	0.60	76°	1.50	85°	2.40
68°	0.70	77°	1.60	86°	2.50

take the specific gravity, but if it has *not* a temperature of 60°, after taking the specific gravity consult the above table of Bird.

Urinometers are constructed for use at a certain temperature, 60° or 62° F., hence when the urine has

a temperature other than 60° or 62° the reading will not be absolutely correct. It will be seen from the table that unless the temperature of the urine be 70° or over, there will be only fractions of one degree difference; thus, suppose on dipping the chemical thermometer into a specimen of urine we find its temperature to be 66°. Taking the specific gravity with the urinometer we find it to be 1030; consulting the table we find five-tenths corresponding to a temperature of 66°, hence the true specific gravity is 1030.5. Suppose now another specimen has a temperature of 86° and a specific gravity of 1028; consulting the table we find 2.5 corresponding to a temperature of 86°, hence 1028+2.5=1030.5 is the true specific gravity. If the urine be of the temperature of the surrounding air in the room its specific gravity will be sufficiently correct for clinical purposes without making the corrections indicated by the table, provided, of course, the room be not of an extreme temperature, hot or cold; if for any particular reason, as in estimation of quantity of urea, etc., the accurate specific gravity be desired, the table should be used. If the urine be below the temperature of the room, warm it.

Estimation of Solids.—To estimate approximately the amount of solid matters contained in the urine, proceed as follows: 1st., collect the urine of twenty-four hours; 2d, measure it in Cubic centimetres by means of a flask graduated in Cubic centimetres; 3d, divide the amount of Cubic centimetres found by 1000 and number the result (I). Next take the specific gravity of the urine and multiply the two right hand figures by 2 (Trapp's coefficient). Multiply this result by the figure numbered (I) above and the product will be the amount of solids (in grammes) in the urine of twenty-four hours. If the amount be desired in *grains* instead of grammes multiply the amount found in grammes by 15.4.

EXAMPLE I.

Amount of urine, 3000 Cubic centimetres in twenty-four hours.

$$3000 \div 1000 = 3. \quad (\text{I.})$$

Specific gravity of urine 1008. $08 \times 2 = 16$, (last two figures of specific gravity multiplied by 2). $16 \times 3 = 48$ (this result multiplied by number found according to (I).

This urine then contains 48 grammes of solids in the total amount passed in twenty-four hours; to find the amount in grains multiply 48 by $15.4 = 739$ grains.

EXAMPLE II.

Amount of urine, 400 Cubic centimetres in twenty-four hours.

$$400 \div 1000 = 0.4. \quad (\text{I.})$$

Specific gravity of urine, 1002. $02 \times 2 = 4$ (last two figures of specific gravity multiplied by 2) $4 \times 0.4 = 1.6$ (this result multiplied by number according to I).

This urine then contains 1.6 grammes of solids in the total amount passed in twenty-four hours; to find the amount of solids in grains multiply 1.6 by 15.4 – 24.6 grains.

This method of calculating the amount of solid constituents may give a result anywhere from $\frac{1}{10}$ to $\frac{1}{4}$ out of the way but it will indicate sufficiently correctly any marked change in the total amounts from day to day.

In calculating the quantity of solid constituents some attention must be paid to the daily amount of food; thus a litre of soup will add nearly fifteen grammes of solid matter to the urine, therefore it is best to ascertain from the patient how much of this substance he has taken in a day, if any.

NORMAL URINE.

(PHYSICAL CHARACTERISTICS.)

Normal urine is a clear liquid of a color varying from light straw to reddish yellow, possessed of an odor peculiar to itself and consisting chiefly of water holding various substances for the most part in solution, such as urea, common salt, phosphates, etc.

Average Composition of Normal Urine in 1,000 Parts.—

Water, - - - - - - - -	949.25
Solids, - - - - - - - -	50.75
Total, - - - - -	1000.00

Organic.

(Water), - - - - - - - - -	949.25
Urea, - - - - - - - - - - -	26.00
Creatin, - - - - - - - - -	traces
Creatinin, - - - - - - - -	1.50
Urates of Sodium and Potassium, -	1.75
Free Uric acid, - - - - - - -	traces
Mucus and coloring matter, - -	0.25

Inorganic.

Acid Phosphate of Sodium, - - - - } Phosphates of Calcium and Magnesium, }	6.25
Chlorides of Sodium and Potassium, -	9.25
Sulphates of Sodium and Potassium, -	5.75
Total, - - - - - - - -	1000.00

Quantity of Normal Urine in Twenty-four Hours.—In general terms the healthy adult passes from forty to sixty fluid ounces of urine during twenty-four hours.

Observations of the Author on the Quantity of Urine Passed Daily.—Having had opportunity to measure the daily quantity of urine passed by an adult man in good health, I give the result of sixty-eight successive daily measurements as follows:

1st day,	- - - -	1008	Cubic centimetres.
2d "	- - - -	1100	" "
3d "	- - - -	705	" "
4th "	- - - -	1625	" "
5th "	- - - -	1135	" "
6th "	- - - -	1104	" "
7th "	- - - -	897	" "
8th "	- - - -	1540	" "
9th "	- - - -	1120	" "
10th "	- - - -	1592	" "
11th "	- - - -	952	" "
12th "	- - - -	898	" "
13th "	- - - -	1188	" "
14th "	- - - -	901	" "
15th "	- - - -	1186	" "
16th "	- - - -	1183	" "
17th "	- - - -	1901	" "
18th "	- - - -	1476	" "
19th "	- - - -	1610	" "
20th "	- - - -	1553	" "
21st "	- - - -	1326	" "
22d "	- - - -	911	" "
23d "	- - - -	1580	" "
24th "	- - - -	965	" "
25th "	- - - -	1885	" "
26th "	- - - -	1283	" "
27th "	- - - -	975	" "
28th "	- - - -	1106	" "
29th "	- - nearly	1250	" "
30th "	- - "	1300	" "
31st "	- - "	1100	"

32d	day, - -	nearly	1200	Cubic	centimetres.
33d	" - -	"	1500	"	"
34th	" - -	"	1500	"	"
35th	" - -	"	1300	"	"
36th	" - -	"	1250	"	"
37th	" - -	"	1600	"	"
38th	" - -	"	750	"	"
39th	" - -	"	1700	"	"
40th	" - -	"	900	"	"
41st	" - -	"	1600	"	"
42d	" - -	"	900	"	"
43d	" - -	"	1300	"	"
44th	" - -	"	2200	"	"
45th	" - -	"	1600	"	"
46th	" - -	"	1700	"	"
47th	" - -	"	1200	"	"
48th	" - -	"	1500	"	"
49th	" - -	"	1000	"	"
50th	" - -	"	1600	"	"
51st	" - -	"	1300	"	"
52d	" - -	"	1200	"	"
53d	" - -	"	1200	"	"
54th	" - -	"	1000	"	"
55th	" - -	"	1500	"	"
56th	" - -	"	1200	"	"
57th	" - -	"	1200	"	"
58th	" - -	"	1325	"	"
59th	" - -	"	1025	"	"
60th	" - -	"	900	"	"
61st	" - -	"	1200	"	"
62d	" - -	"	1300	"	"
63d	" morning and night	only	600	"	"
64th	" - -	- -	1200	"	"
65th	" - -	- -	1400	"	"
66th	" - -	- -	1200	"	"
67th	" - -	- -	1300	"	"
68th	" - -	- -	1400	"	"

During the first twenty-eight days the measurements were made with close accuracy; during the last forty days the quantity was measured and the results given in round numbers.

Daily average for first 28 days, 1249.46 C. c.
" " " last 39 days, 1300 " "(nearly).
Greatest quantity voided on any day 2200 C. c.
Least " " " " " 705 " "

On the sixty-third day owing to unavoidable circumstances, only the urine passed in the morning and at night was collected, amounting to 600 Cubic centimetres; the quantity for that day is therefore omitted in making up the averages.

During the sixty-eight days, when the daily amount was being collected and measured, a routine life was led, late hours avoided, and no alcoholic liquors of any kind taken, and every care observed that one day should be as nearly alike another as possible. The diet was as nutritious and hearty as compatible with a sedentary life, indigestible food being carefully shunned. The only fluids taken were cold water (without ice) between meals, and at meals very weak tea; no coffee was drunk during the entire period and the tea was made as weak as was possibly palatable. A small amount of very mild tobacco was smoked after lunch and after dinner, the latter being at six o'clock. It would appear, therefore, that a healthy, well-nourished male adult, leading a quiet life and not drinking much, passes on an average from 1250 to 1300 Cubic centimetres of urine daily, or about forty-two fluid ounces. Persons of active temperaments and strong constitutions may pass, normally, considerably more than forty-two fluid ounces; in fact, various conditions affect the daily quantity of urine in the healthy individual as follows:

Circumstances, not due to disease nor drugs, increasing the amount of urine.

I. Activity of the kidneys: greater during bodily and mental activity and less during rest and sleep.

II. Copious drinking of fluids, especially when little perspiration.

III. Cold, damp weather (little perspiration).

IV. Animal diet: nitrogenous food in general.

V. Non-retention in bladder for any length of time.

VI. Age and sex: children *relatively* more than adults; males than females.

Circumstances, not due to disease nor drugs, decreasing the amount of urine.

I. Inactivity of kidneys: during rest and sleep or abstinence from mental or physical exertions.

II. Abstinence from drinking.

III. Activity of cutaneous and pulmonary exhalations, (after exercising accompanied by profuse perspiration, urine scanty).

IV. Warm, dry weather : (much perspiration).

V. Non-nitrogenous diet.

VI. Retention in the bladder for some time: (re-absorbed into the circulation).

VII. Age and sex.

Quantity of Urine Passed at Different times in the day.—The urine passed on rising in the morning is called *urina sanguinis*, that after a meal *urina cibi* or *chyli*, that after drinking *urina potus*.

When the daily quantity for sixty-eight days was collected, account was kept of the urine voided at different times in the day for the first twenty-eight days, as follows :

1st day, urina sanguinis,	-	178	Cubic centimetres.
12 noon,	- -	55	"
1.30 P. M.,	- -	100	"
6.30 "	- -	400	"
10.30 "	- -	275	"

Number of urinations, 5.

2d day, sanguinis,	- -	125	Cubic centimetres.
3.30 P. M.,	- -	475	"
10.30 "	- -	400	"

Number of urinations, 3.

3d day, sanguinis,	- -	150	Cubic centimetres.
12 noon,	- -	175	"
3.30 P. M.,	-	110	"
6.00 "	-	100	"
10.30 "	-	170	"

Number of urinations, 5.

4th day, sanguinis,	- -	275	Cubic centimetres.
1.00 P. M.,	-	200	"
3.30 " -	-	460	"
6.00 " -	-	175	"
11.00 " -	-	515	"

Number of urinations, 5.

5th day, sanguinis,	- -	220	Cubic centimetres.
1.00 P. M.,	-	160	"
3.30 "	-	155	"
5.30 "	-	200	"
11.00 "	-	400	"

Number of urinations, 5.

6th day, sanguinis,	- -	245	Cubic centimetres.
1.00 P. M.,	-	185	"
3.30 "	-	337	"
10.00 "	-	337	"

Number of urinations, 4.

7th day,	sanguinis, - -	337	Cubic centimetres.
	2.30 P. M., -	160	"
	10.30 " -	400	"

Number of urinations, 3.

8th day,	sanguinis, - -	305	Cubic centimetres.
	3.00 P. M., -	135	"
	7.00 " -	400	"
	9.30 " -	700	"

Number of urinations, 4.

9th day,	sanguinis, - -	280	Cubic centimetres.
	1.00 P. M., -	125	"
	3.30 " -	275	"
	6.30 " -	160	"
	11.00 " -	280	"

Number of urinations, 5.

10th day,	sanguinis, - -	337	Cubic centimetres.
	12 noon, - -	175	"
	2.30 P. M., -	345	"
	6.30 " -	350	"
	11.00 " -	385	"

Number of urinations, 5.

11th day,	sanguinis, - -	130	Cubic centimetres.
	12.30 P. M., -	95	"
	3.30 " -	366	"
	4.30 " -	83	"
	10.00 " -	278	"

Number of urinations, 5.

12th day,	sanguinis, - -	260	Cubic centimetres.
	2.00 P. M., -	140	"
	7.30 " -	278	"
	10.00 " -	220	"

Number of urinations, 4.

13th day, sanguinis,	- -	278	Cubic centimetres.
11.00 A. M.,	-	80	"
2.00 P. M.,	-	270	"
4.30 "	-	290	"
10.00 "	-	270	"

Number of urinations, 5.

14th day, sanguinis,	- -	330	Cubic centimetres.
12 noon,	- -	140	"
10.30 P. M.,	-	431	"

Number of urinations, 3.

15th day, sanguinis,	- -	278	Cubic centimetres.
3.30 P. M.,	-	278	"
6.30 "	-	225	"
9.00 "	-	475	"

Number of urinations, 4.

16th day, sanguinis,	- -	278	Cubic centimetres.
12 noon,	- -	100	"
6.00 P. M.,	-	580	"
11.30 "	-	225	"

Number of urinations, 4.

17th day, sanguinis,	- -	278	Cubic centimetres.
12 noon,	- -	225	"
3.30 P. M.,	-	813	"
6.30 "	-	425	"
10.15 "	-	160	"

Number of urinations, 5.

18th day, sanguinis,	-	333	Cubic centimetres.
12 noon,	-	195	"
3.30 P. M.,	-	278	"
6.30 "	-	520	"
10.00 "	-	150	"

Number of urinations, 5.

19th day, sanguinis,	-	361	Cubic centimetres.
12 noon,	-	160	"
3.30 P. M.,	-	603	"
6.00 "	-	323	"
10.30 "	-	163	"

Number of urinations, 5.

20th day, sanguinis,	-	340	Cubic centimetres.
12 noon,	-	180	"
3.30 P. M.,	-	338	"
6.00 "	-	417	"
11.00 "	-	278	"

Number of urinations, 5.

21st day, sanguinis,	-	378	Cubic centimetres.
12 noon,	-	278	"
6.30 P. M.,	-	325	"
11.00 "	-	345	"

Number of urinations, 4.

22d day, sanguinis,	-	278	Cubic centimetres.
4.00 P. M.,	-	310	"
6.00 "	-	90	"
11.00 "	-	233	"

Number of urinations, 4.

23d day, sanguinis,	-	255	Cubic centimetres.
12 noon,	-	170	"
3.30 P. M.,	-	650	"
6.30 "	-	320	"
10.00 "	-	185	"

Number of urinations, 5.

24th day, sanguinis,	-	300	Cubic centimetres.
12 noon,	-	175	"
6.30 P. M.,	-	300	"
10.30 "	-	190	"

Number of urinations, 4.

25th day,	sanguinis, - -	390	Cubic centimetres.
	12 noon, - -	200	"
	3.30 P. M., -	745	"
	6.15 " -	350	"
	10.30 " -	200	"
	Number of urinations, 5.		
26th day,	sanguinis, - -	300	Cubic centimetres.
	12 noon, - -	175	"
	3.3C P. M., -	400	"
	6.30 " -	175	"
	10.30 " -	133	"
	Number of urinations, 5.		
27th day,	sanguinis, - -	300	Cubic centimetres.
	6.30 P. M., -	500	"
	10.00 " -	175	"
	Number of urinations, 3.		
28th day,	sanguinis, - -	400	Cubic centimetres.
	12 noon, - -	100	"
	4.00 P. M., -	200	"
	11.00 " -	400	"
	Number of urinations, 4.		

SUMMARY.

Average number of urinations, daily - -	4 to 5.
Average quantity voided at each urination,	282.1 C.c.
Greatest quantity voided at any one urination - - - -	813.0 "
Least quantity voided at any one urination,	55.0 "
Average quantity of urina sanguinis, - -	282.7 "
Average quantity passed before retiring,	299.0 "

The urine passed before retiring was in each case, as a rule, *urina cibi*, the principal meal of the day occurring at 6 P. M.

The greatest quantity of urine voided at any one urination, 813 Cubic centimetres, at 3.30 P. M., on the 17th day, was combined *urina cibi* (after lunch at

12.45) and *urina potus*—three glasses of water having been drunk between the hours of 2 and 3 P. M.

Specific Gravity.—The specific gravity of normal urine is said to lie on an average between 1015 and 1025.

Circumstances not due to disease nor drugs increasing the relative amount of solids in the urine, i. e., increasing the specific gravity.

I. Time of day: urina sanguinis.

II. Hearty meals, after: urina chyli.

III. Causes *decreasing* the quantity of fluid.

Circumstances not due to disease nor drugs decreasing the specific gravity.

I. Copious draughts of fluids (urina potus).

II. Causes *increasing* the quantity of fluid.

The specific gravity of urina sanguinis should be from 1015 to 1025; of urina cibi, 1020 to 1030; that of urina potus, 1010 to 1020.

Solid Constituents.—The urine of an healthy adult contains, dissolved in it, from sixty to seventy grammes (925 to 1075 grains) of solid matters, urea, salts, etc., during the twenty-four hours.

Consistence.—Normal urine is a thin, easily dropping fluid, foaming if shaken; this foam vanishes soon on standing.

Transparency and Fluorescence.—Normal urine is always clear and transparent, showing, after standing at rest for some time, a very slight turbidity or light, grayish-white cloud which gradually settles to the bottom of the vessel. This cloud, called nubecula, is derived from the bladder and is composed mainly of mucus and epithelial cells; it is generally more apparent in the urine of women than that of men, but should never be sufficiently visible to attract attention. Normal urine shows at times a peculiar white fluorescence.

Color.—The color of normal urine varies from pale straw, or almost colorless after copious draughts of water, through yellow to red, after hearty meals or free perspiration; the standard "normal" color as in winter, is wine yellow or amber, called by some "sherry color".

Odor.—The odor of fresh, normal urine is slightly aromatic, and is called "*sui generis*"—peculiar to itself.

The odor is stronger in proportion to the amount of solids contained in the urine. The urine passed after a hearty meal smells stronger than that after copious draughts of water. The urine of infants is generally inodorous; on standing it acquires the agreeable savor of veal broth but is not quite so nourishing.

Urine, on standing exposed to the air for some time, loses its *sui generis* odor and takes on, first, a smell somewhat like that of sour milk and, subsequently, a fetid ammoniacal odor.

Reaction.—Normal urine of twenty-four hours turns blue litmus paper dipped into it slightly red; after a meal it may turn neither blue litmus paper red, nor red litmus paper blue; after a meal or after a cold bath it may turn red paper blue. In other words, normal urine is slightly acid in reaction; it may be neutral or alkaline after meals, or alkaline after a cold bath. Vegetable diet tends to make urine neutral.

ABNORMAL URINE.

(PHYSICAL CHARACTERISTICS.)

The quantity, specific gravity, solids, consistence, color, transparence, odor, and reaction of normal urine being known it is now in order to study the departures from normal standards shown in the physical characteristics of abnormal urine.

Increased Quantity of the Twenty-four Hours' Urine.—A large increase in the total amount of urine for twenty-four hours is indicative of diabetes, either mellitus or insipidus, especially if the daily increase of quantity above normal is persistent, and on calculation we find the amount of solids likewise increased.

In diabetes mellitus the daily amount of urine voided may be enormous.

In case the total amount of urine for twenty-four hours is *increased* (above normal) while the solid matters are *below* normal in amount, increase of the *water* in the urine is indicated, which is called *hydruria*, and is neither diabetes mellitus nor diabetes insipidus. Cases of this sort have been noticed in rheumatism, the daily amount averaging 3000 Cubic centimetres (about three quarts) while the average amount of solid constituents was only 42 grammes (647 grains). "In such cases no emaciation results, but, on the contrary, diseased products are often removed, as in many cases of hydræmia and dropsy."

Lastly when the amount of urine is in excess of normal, and the quantity of solid matters passed remains within normal limits we ought to suspect a large amount of fluids to have been drunk.

An increase above normal limits in the total amount of urine for twenty-four hours is called *polyuria;* polyuria may be divided into two classes: increase in

amount of urine, with *increase* in solids, called *diabetes*, (two forms "mellitus" and "insipidus") and increase in amount of urine, with *decrease* in solids, called *hydruria*.

The word *polyuria* is derived from two Greek words signifying "much urine"; the word *hydruria*. "watery urine"; or "flow of much urine" and "flow of watery urine" respectively.

It will be borne in mind that an increased amount of urine due to excessive drinking is called "urina potus," is not pathological since the amount of solids does not exceed normal limits in either direction, and does not come under the head of *polyuria*.

Diabetes, the first form of polyuria, in which the amount of the solids is increased, may be of two forms: diabetes mellitus and diabetes insipidus.

Diabetes *mellitus* (mellitus from *mel* "honey") is saccharine diabetes, i. e., diabetes where sugar is present in the urine; diabetes *insipidus* (insipidus form *in* and *sapor*, "tasteless") is diabetes where sugar is absent but an abnormally large amount of other solids present in the urine.

The word *diabetes* then means "increased flow of urine with increased excretion of solid matters," whether sugar and normal constituents (in which case the qualifying term "mellitus" is added) or normal constituents *without* sugar (in which case the term "insipidus" is used).

Diabetes of any kind is accompanied by weakness and emaciation; *hydruria* is not accompanied by either of these.

In certain forms of Bright's disease, namely, in interstitial nephritis and in amyloid degeneration of the kidney the amount of urine is largely increased —even to three or four times the normal quantity; just before death, however, the quantity falls below normal.

Temporary Increase in Amount of Urine.—Temporary increase of urine is noted after hysterical paroxysms and other convulsive attacks in both males and females.

Increased Tension.—Any increase of tension in the arterial system as in some cases of hypertrophy of the left ventricle of the heart will tend to cause an increase in the quantity of urine.

Decreased Quantity of Twenty-four hours.—Leaving the cases where the urine in amount *exceeds* the normal limit for twenty-four hours and turning our attention to a *decreased* amount we find that "*at the height of all acute febrile diseases* the quantity of urine is considerably diminished."

Moreover the quantity of urine passed daily in acute disease gives us important indications: "*A constant daily diminution of the quantity of the urine indicates that the intensity of the disease is increasing—a continued low quantity of the urine* (*below* 800 *Cubic centimetres, or* 1 3-5 *pints per diem*) *shows that the intensity of the disease has not diminished—while a steady increase of the quantity of urine shows that the force of the disease has been broken.*"—Vogel.

During convalescence the quantity of urine becomes normal or may even exceed that limit.

In the paroxysms of intermittent fever, i. e., during the *chill*, the quantity of urine is not always scanty, nor is it always in the acute rheumatism of childhood where there is mitral insufficiency or hydræmia.

In *typhus* fever, a profuse flow of normal urine is sometimes noticed at the height of the disease.

Wilson says that in *cerebro-spinal* fever the quantity may be much increased even when the fever is active and the temperature high.

The above are the principal exceptions to the gen-

eral rule of the quantity of urine in fevers, and should be carefully noted.

In general, all types of violent fever and inflammation are likely to be attended by suppression of the urine, as scarlatinal nephritis and yellow fever; suppression of urine is noted also in the collapse of cholera, in later stages of organic diseases of the kidneys, and when any mechanical obstacle obstructs the flow of urine, as after catheterism. The urine is scanty in amount in cirrhosis of the liver and in scurvy. Any condition of the heart leading to passive congestion of renal veins, by which the circulation through the kidneys is impeded, will diminish the amount of urine. After copious vomiting or abundant watery stools the urine is diminished.

Urine in Bright's Disease.—The quantity of urine is diminished in some forms of Bright's disease: (1) in the *early stages* of acute parenchymatous nephritis, (2) in chronic parenchymatous nephritis, (3) in interstitial nephritis or amyloid degeneration if complicated with acute or chronic parenchymatous nephritis according to the extent of the parenchymatous complication, (4) sometimes in the last stages of all forms.

Effect of Drugs on the Quantity of Urine.—Administration of the so-called diuretics, such as acetate of potassium, Spiritus Ætheris Nitrosi, etc., will *increase* the quantity of urine; also inhalation of oxygen, chronic lead-poisoning (irregular transitory polyuria), etc.

Mineral salts such as those of iron and copper *decrease* the amount of urine; potassium chlorate when given in small doses will increase the amount, but in heavy doses will first suppress the urine and then cause an abundant flow of bloody albuminous urine. The urine is decreased in poisoning from external use of pyrogallic acid (Meisser), of aniline

compounds, and of atropine (as a collyrium); in poisoning from phosphorus taken internally.

The urine is decreased, often to suppression, in poisoning from or after heavy doses of, cantharides, arsenic, carbolic acid, ergot, iodine, mercury, opium.

Specific Gravity.—In drawing conclusions from the specific gravity of urine the *quantity* for twenty-four hours must be considered. Urine of high specific gravity (above 1025), but *small* in quantity and heightened in color is characteristic of a *febrile* condition; bear in mind the fact that abstinence from drinking, coupled with profuse perspiration will cause similar conditions. Urine of high specific gravity with *increased* amount in twenty-four hours, especially if continuing for some time, is characteristic of diabetes mellitus. Urine of *lowered* specific gravity and *increased* amount is characteristic of diabetes insipidus. (In dropsy or hydræmia a large amount of urine low in specific gravity is a favorable sign, and should not be confounded with the conditions obtaining in diabetes insipidus).

Lastly, and most important to the practitioner, if the daily quantity of urine is small and the specific gravity lower than normal we have reason to fear uræmia; conditions of this kind frequently indicate an alteration of the kidneys as observed in Bright's disease. It must be observed that the rules given above are for the majority of cases; in diabetes insipidus the specific gravity is not always below normal, and cases of diabetes mellitus have been observed where the specific gravity was not remarkably high.

Summary for Specific Gravity.—Urine is pathological if, the quantity for twenty-four hours being collected, we observe:

(1) Specific gravity high, color high, quantity small.

(2) Specific gravity high, color pale, quantity large.

(3) Specific gravity low, color of deep tint, quantity large.

(4) Specific gravity low, urine more less colorless, quantity small.

The urine for twenty-four hours having been collected on different occasions, if we observe :

(1) Specific gravity persistently below 1015, suspect albuminuria.

(2) Specific gravity persistently below, say 1008, suspect diabetes insipidus, hydruria, or albuminuria.

(3) Specific gravity persistently above 1025, color pale, suspect diabetes mellitus.

(4) Specific gravity persistently above 1025, color high, suspect febrile state.

EXAMPLE.

CASE 1.—Quantity in twenty-four hours averages 900 Cubic centimetres ($\frac{9}{10}$ qt.). Specific gravity averages 1030 to 1035. Color always high. The case is one of severe fever.

CASE 2.—Quantity in twenty-four hours averages daily 4800 Cubic centimetres (5 qts. nearly). Specific gravity averages daily 1025 to 1035. Urine contains sugar. Diagnosis, diabetes mellitus.

CASE 3.—Quantity in twenty-four hours averages daily 3500 Cubic centimetres ($3\frac{1}{2}$ qts.). Specific gravity averages daily about 1015. No sugar found in the urine and the case is one of diabetes insipidus.

CASE 4.—Quantity in twenty-four hours averages 600 Cubic centimetres $1\frac{1}{5}$ pints). Specific gravity averages 1010. The case is one of chronic Bright's disease.

The above cases are given merely to illustrate principles and are by no means intended to serve as sole guides to diagnosis.

Solids.—If the daily amount of solids is persistently increased, when at the same time the patient is

not living on animal food chiefly, nor animal broths, destruction of the tissues of the body, excessive in nature, may be indicated. In drawing conclusions in regard to the amount of solid matters, consider also the quantity of urine daily and the specific gravity.

CASE 1.—Quantity, daily, averages 4000 Cubic centimetres; specific gravity, daily, averages 1007; solids (estimated by method previously given) 56 grammes (862 grains). The amount of solids is nearly normal but the quantity and specific gravity of the urine are abnormal—in other words, the *fluid* has been increased in amount, and either excessive drinking, on the part of the person, may be indicated, or, if he be suffering from dropsy or hydræmia, the system is endeavoring to throw off the surplus fluid and the condition of the urine is a favorable sign.

CASE 2.—Quantity, daily, averages 6000 Cubic centimetres (six quarts); specific gravity, daily, averages 1014; solids, 168 grammes (2,587 grains). The solids are largely increased, likewise the fluid, and some form of diabetes may be indicated. Testing the urine for sugar, in the manner hereafter to be described, would tell us which form of diabetes was present, care being taken, if sugar be found, to test the urine repeatedly for it for sometime afterward.

If urine of normal or decreased quantity daily, of low specific gravity and decreased amount of solids, occur, we may suspect some impediment to the secretion of urea and have reason to fear the results of retention of urea in the body (uræmia). In acute nephritis the specific gravity may be high.

We find in most chronic diseases except diabetes, the daily amount of solids decreased; an increase of them is then, as a rule, a sign of more favorable conditions, such as more active metamorphosis or better nutrition, while, on the other hand, an increase of the

solid matters at the height of an acute disease is usually an unfavorable sign, because the inanition which always occurs in such cases is thereby increased and favored. (Vogel).

Lastly, in the case of a patient who, on account of a febrile disorder has fasted or taken but little food, we must not deem sixty or seventy grammes (924 to 1078 grains) of solids (computed from the amount and the specific gravity) to be by any means normal, but largely in excess. When we say that sixty to seventy grammes is the normal amount per diem, we of course presuppose ordinary health and ordinary diet. In the case of a person suffering from an acute febrile disorder, 30 grammes (462 grains) will be an average amount, and if this rises to 40 or 50 (616 to 770 grains), on a strict and careful diet, it is at the expense of the body and is an unfavorable sign.

In chronic lead-poisoning the amount of solids is greatly reduced.

Summary: (1) Increased quantity, decreased specific gravity, with normal amount of solids, simply means increase in fluid, and may be physiological or occur in certain cases of dropsy; (2) Increased quantity, normal, increased or even decreased specific gravity with increased solids, indicates diabetes; (3) Normal or diminished quantity, diminished specific gravity and diminished amount of solids, means often uræmia, and may occur in Bright's disease.

Color.—Urines of abnormal color may be classified as follows:

I. Nearly colorless: neuroses, cirrhosis of kidney.

II. Watery urine and diabetic urine showing slight tinge of yellow, which on standing may become darker.

III. High-colored urine, color dark yellow to red

or even flame red, found in acute febrile disorders.

IV. Blood-red urine, caused by foreign coloring matter, or by the passage of blood into the urine.

V. Dark brown to nearly black urine in (1) kidney diseases, especially hemorrhages, when (2) bile coloring matters enter the urine, in (3) long-continued intermittent fever.

VI. Green urine, dirty in hue, in jaundice when bile coloring matter is present in the urine—so-called "icteric" urine.

VII. Dirty-blue urine chiefly in cholera and typhus.

In familiar language, the abnormal colors shown by urine or its sediments may be classified as follows:

"Smoky" colored urine: due to presence of blood.

(It is said that presence of spermatozoa can not be suspected from the appearance of the urine.)

White urine: due to the presence of pus or chyle.

Black urine: due to presence of (1) melanin, or to (2) drugs, or found in (3) renal diseases.

Brown or green urine: due to presence of bile.

Pale urine: in chlorosis, anæmia, diabetes, atonic gout, hysteria, cirrhosis of kidney.

High-colored: in (1) organic disease of the liver, (2) febrile states or inflammations.

"Milky": due to deposits of phosphates or white urates. See also White Urine.

Influence of Drugs on Color of Urine:

Carbolic acid, externally or internally, darkens the urine.

Sulphuric acid, creasote, arseniuretted hydrogen cause black tint.

Inunction of tar causes black tint.

Gallic and tannic acids cause dusky hue.

Strong coffee darkens the urine.

Indigo: greenish blue.

Aloes; deep red.

Madder, campeachy wood, mulberries: red.

Alizarin: rose-colored.

Gamboge, senna, logwood, picrotoxin: yellow.

Santonin: rich golden yellow in acid urine; orange red in alkaline.

Rhubarb: deep gamboge yellow changed to red on addition of ammonia.

Resin: grayish yellow.

In regard to the dark color of the urine, caused by carbolic acid poisoning, Reichert says that in 56 such cases he found 20 per cent were colored dark; this color may appear in two hours or so, and last several days and at times is only perceived by holding the urine to the light. According to Kirmisson, if the urine have a dark or a dark green hue, care should be taken about continuing the use of the acid. In chlorate of potassium poisoning the urine may be colored black.

In a case of poisoning by duboisin, recorded by Berner, the urine was as colorless as water.

In a case of poisoning from the external use of carbolic acid, reported by Weiss, the urine first became dark colored, but subsequently lost this coloration and became chylous.

In two cases of poisoning from the external use of aniline chlorhydrate for psoriasis, the urine was colored *dark red.* (Lailler).

In a case of poisoning from the external use of pyrogallic acid, the urine became dark brown. (Neisser).

The urine of a patient suffering from a *burn* may be brownish green, from presence of bile pigments.

In cases of chronic lead-poisoning the urine, after anæmia or icterus has set in, may become brown from presence of blood pigment; subsequently, abundant and clear. (Gautier).

According to Robin (Essai d' Urologie Clinique) there are three varieties of *blue* urine:

I. Urine blue at time of emission.

II. Urine becoming blue after standing several hours.

III. Urine containing blue layers.

The first variety, that blue at time of emission, is very rare, and only two cases have come under his observation.

He has seen eight cases of the second variety, in typhoid fever, and deems blue urine in this disease a favorable sign.

In chronic affections of the spinal cord he has seen two cases of the third variety.

Transparence.—We have learned that normal urine should be clear with the merest cloud of mucus, etc., settling to the bottom on standing.

If the urine is clouded within eight to ten hours after it is passed or at the time it is passed, it contains those substances which after long standing form a sediment, (see Sediments) and is pathological.

We caution physicians against inferring that, because the urine is transparent, it is necessarily normal; but, on the other hand, distinct turbidity always allows us to conclude that there is some abnormal condition. Urine may be perfectly clear when first passed, but on cooling throw down a sediment of urates, especially in cold weather. Opaque urine which on heating and application of acids becomes turbid may contain albumin or pus.

Urine turbid when *first passed* often contains *pus.* A whitish sediment in urine may be phosphates or possibly urates; heat clears urates; a drop or two of nitric acid clears phosphates, the urine after such treatment appearing normal.

Consistence.—Hippocrates said that "bubbles

maintained upon the top of the urine signify a disease of the reins and, likewise, its long continuance," a fact which Dr. Southey, in his Lumleian Lectures on Bright's Disease, remarks, remained unimportant until the end of the last century, when it was ascertained that albuminous urine held a froth of bubbles on its surface.

Hassall, in reviewing these statements affirms that the persistent presence of air-bubbles on the surface of urine may be noted in most cases of albuminuria, but that it does not follow that all urine which froths is albuminous; he thinks the frothing in some cases to be connected with the high density of the urine; in others, with its feeble acidity or alkalinity; in others, with an excess of mucus.

In general, the occurrence of retained and persistent air bubbles on the surface of urine is nearly always of pathological significance. Kirk thinks that fatty or oily matter in the urine prevents the formation of bubbles.

Pathologically, we find the urine viscid, when containing pus in large amount.

Urine containing bile foams easily and profusely.

In urine containing sugar or albumin, any foam which may gather will remain longer than in the case of healthy urine.

When the urine has become strongly alkaline and contains at the same time *pus*, it will often become so stringy and tenacious as not to drop from the tube or vessel.

Chylous urine (urine containing chyle) is often jelly-like in consistency, after being voided.

King mentions having seen several specimens of urine white in color and of creamy consistence, forming a thick jelly-like mass shortly after being voided; he found in such urine no fat of any kind, but an incredible amount of mucus and phosphates.

Odor.—If the odor of urine be ammoniacal and repulsive it may be merely stale, hence ascertain how long it has stood; urine on standing, especially in summer, or in a warm room, will become alkaline in time, if exposed to the air, and take on a disgusting odor. If this offensive odor is noticeable soon after the urine is passed into a clean vessel, then the urine is pathological, indicating decomposition of it within the body.

Such putrid, offensive urine of an alkaline reaction is found in the affections of the brain and cord and in certain genito-urinary diseases, especially in advanced cases of severe cystitis, or destructive renal diseases; in certain renal diseases the odor is often gangrenous.

Fresh diabetic urine smells sweetish; *stale*, like sour milk; purulent and sanious discharges in the urine cause a stale, offensive odor like that of tainted flesh.

Certain articles of diet, as asparagus, cauliflower, garlic, onions, and certain drugs, as turpentine, valerian, asafœtida, castor oil, copaiba, cubebs, sandalwood oil, communicate certain peculiar odors to the urine.

Reaction.—The normal reaction of the urine is known to be slightly acid i. e., turns blue litmus slightly red; on standing some time "acid fermentation," so-called sets in and the urine becomes strongly acid, i. e., turns blue litmus paper bright red, then subsequently becomes strongly alkaline, after the so-called "alkaline fermentation" sets in. Exceptions, however, occur; some specimens will not necessarily observe the above-mentioned sequence of reactions.

Before the physician decides upon the clinical signification of the reaction of the urine, he must ascertain how long the urine has been standing, and if

over twenty-four hours its reaction is not always a reliable guide.

Two conditions of the urine are of clinical significance:

I. Strong acidity when freshly passed.

II. Alkalinity within twenty-four hours.

Diseases in which the Freshly Voided Urine is Strongly Acid:

I. Fevers, inflammations, especially liver, heart, lungs.

II. The urine may be strongly acid and yet no acute febrile disturbance be present; in this case the formation of sediments and concretions is to be feared, especially of uric acid.

It is difficult to increase sensibly the acidity of urine by administering acids; but if it is desirable that the urine be kept steadily alkaline, 300 or 400 grains daily of bicarbonate of soda or potash, or of the acetate or citrate of either of these bases, will bring about the desired results.

Diseases in which the Urine may become Alkaline within twenty-four hours.

I. Debility, exhaustion from over-work, care, anxiety, etc.

II. Anæmic states following subacute rheumatism and gout.

III. Chlorosis.

IV. Functional derangements of the liver with diminished secretion of bile: dyspepsia, chronic vomiting.

V. Many acute diseases, as typhus, scarlet fever, enteric troubles, pneumonia, and convalescence from same.

IV. Pulmonary complaints, as in phthisis: long continued respiration of impure air.

[The alkalinity in the cases (I.–VI.) is due to the presence of *fixed* alkali so-called, i. e., potash or soda

not ammonia; such urine shows no tendency to contain gravel or calculi and is not associated with inflammation of the urinary passages].

VII. Local affections of mucous membrane of lower urinary passages: (1) Bladder troubles as paraplegia with paralysis of bladder, morbid growths, calculous concretions, cystitis; (2) obstinate urethral stricture, enlarged prostate.

Conditions which interfere with the complete emptying of the bladder render the urine alkaline from development of ammonium carbonate into which urea is changed (by the presence of a "ferment" called by Bechamp, nephrozymase), when for any cause the urine either wholly or in part is retained in the bladder.

Urine which is alkaline when first passed, or very soon thereafter, from ammonia is irritating to the mucous membrane and leads to cystitis. Such urine *always* contains a sediment of phosphates (amorphous lime-phosphate and ammonio-magnesium, or triple phosphate, together with spheres and dumbbells of ammonium urate which tend to gather together into masses). It is ammoniacal, often putrescent in odor.

It is important that the physician be able to distinguish between urine alkaline from presence of a fixed alkali and urine alkaline from presence of ammonia.

Urine alkaline from fixed alkali.

I. Bland and innocuous to the mucous membranes.

II. No inflammation of urinary passages.

III. Pleasant, often aromatic odor.

IV. Seldom contains sediment; if any, amorphous phosphate of lime.

V. Turns red litmus paper *permanent* blue.

Urine alkaline from ammonia.

I. Irritating to the mucous membranes.

II. Inflammation of urinary passages.

III. Ammoniacal or offensively putrescent odor.

IV. Contains abundant deposits, phosphates (amorphous and triple).

V. Turns red litmus paper blue which fades to red again on exposure for a short time to air.

Cautions.—Before deciding that the urine is alkaline from ammonia be sure, (1) that it is alkaline when first passed, (2) that the vessel containing it was *perfectly clean.* Always remember (1) that stale urine which has been exposed to the air becomes, in time, ammoniacal, (2) that, if a vessel contain a little stale urine, fresh urine passed into it *rapidly* becomes ammoniacal. The physician must see that the chamber vessel and urine glasses of the patient are not merely emptied but thoroughly washed so that every trace of the stale urine is removed.

Agents which exert an influence on various conditions of the urine.

I. Solid matters in the urine are increased by appreciable doses of digitalis, belladonna, colchicum, carbonate of potassa, white Rhine-wine and many other agents. Masterman has shown (*Lancet*, October, 1880,) that *beef tea* is analogous in its chemical analysis to urine except that it contains less urea and uric acid.

II. The solids are decreased in the urine by citrate of quinia and iron, ammonio-citrate of iron with quassia, alcohol, beer, coca, tea, coffee, and Paraguay tea; also by opium, morphia, conium, calabar-bean, hyoscyamus, cannabis. It is necessary to exercise some care in decreasing the solids in the urine by use of the last named drugs owing to their action on the nervous system.

III. The fluids of the urine are increased by sweet spirits of nitre, beer, gin, turpentine, whisky, coffee

without sugar or milk, large draughts of soft water, and by other agents called *diuretics.*

IV The fluids are diminished by conine, citrate of quinine and iron; iron, copper, and ammonio-citrate of iron with quassia; arsenic and cantharides in appreciable doses may almost wholly arrest the flow of urine.

CLINICAL SUMMARY.

(PHYSICAL CHARACTERISTICS).

Quantity in Twenty-Four Hours.—Possible normal range, 800 to 2000 Cubic centimetres ($1\frac{1}{2}$ to 4 pints, nearly).

Usual normal range, 1200 to 1400 Cubic centimetres ($2\frac{1}{2}$ to $2\frac{7}{8}$ pints, nearly).

Large persistent increase (over 2000 Cubic centimetres), suspect (1) diabetes; (2) certain forms of Bright's disease.

Temporary increase, after (1) hysterical paroxysms; (2) other convulsive attacks of both sexes.

Decreased quantity, in (1) height of all acute febrile disorders, (2) certain stages of Bright's disease and dropsy, (3) cirrhosis of liver. Sudden decrease, fear uræmia in cases of nephritis.

Color.—Normal range, golden-yellow to amber.

Pale, after copious drinking (urina potus) also in (1) anæmia and chlorosis, (2) diabetes, (3) hysteria and convulsions, (4) convalescence from acute diseases, (5) atonic gout, (6) cirrhosis of kidney.

High, in fevers, acute diseases, etc.

Abnormally colored, from (1) disease or (2) accidental constituents.

Odor.—Normal, sui generis, urinous.

Sweetish, whey-like or like sour milk, in diabetes mellitus.

Ammoniacal or putrid, decomposed urine; if so when freshly passed suspect cystic troubles.

Gangrenous, in some forms of Bright's disease.

Aspect.—If clear not necessarily normal, but if normal must be clear.

Turbid, when freshly passed, suspect presence of *pus*, *mucus*, *epithelial cells*, etc., suggesting cystic troubles.

Clear, when first passed, but sedimentary on cooling, *urates* may be present.

Reaction.—Normal range, slightly acid to neutral or alkaline (after meals).

Strongly acid, in febrile disorders.

Alkaline (from fixed alkali) in (1) anæmia and chlorosis, (2) pulmonary disorders and (3) some acute diseases.

Alkaline, (from volatile alkali), when freshly passed, in cystic troubles.

Specific Gravity.—Normal range, 1015 to 1025.

High, in febrile states—1030 to 1040.

Permanently high in diabetes mellitus—1030 to 1055.

Low, when quantity large, (1) urina potus, (2) polyuria and certain stages of dropsy.

Low, when quantity small, certain stages Bright's disease.

Solids.—Normal amount 55 to 75 grammes (850 to 1155 grains, nearly).

Decreased (1) in acute diseases (40 to 50 grammes) or (2) when quantity of urine abundant *hydruria* (many cases of hydræmia and dropsy). (3) most chronic diseases. N. B.—Increase of solids of the urine at the height of acute diseases usually an unfavorable sign.

Increased, in diabetes.

CHAPTER II.

ALBUMIN, BILE, SUGAR.

Detection of Albumin. — Filter (a) the urine entirely clear, pour into test-tube to depth of an inch, cause an equal bulk of strong nitric acid to flow slowly down the inside of the tube: a zone of turbidity is seen if albumin is present. To confirm (b), take a test-tube, preferably a long narrow one, fill nearly full with urine, add a drop of acetic acid, boil the upper part only, holding the closed end of the tube between thumb and forefinger; a turbidity seen in the urine where it has been boiled indicates presence of albumin.

I recommend the above method as best suited for a routine test, to the general practitioner. Where albumin is present in any notable amount, error is impossible, if the test is properly performed; *both tests* (a) and (b) should be successful, i. e. a turbidity should be noticed in both test-tubes.

Possible Results.—A turbidity may be obtained with test (a) but not with test (b). *Albumin is not present*, as test (b) is more delicate than test (a). The turbidity obtained in (a) is probably due to urates which, if excess in urine, are precipitated by acid.

2. A turbidity is obtained with test (b), but not with test (a): in case acetic acid has been added *and not forgotten*, there is probably a small amount of albumin present. Let the test-tube in which test (a) was performed stand for a few hours, and possibly a few whitish flakes of albumin may be noticed; these will not be cleared up by heat.

3. No turbidity is noticed with either test: absence of any notable amount of albumin. Hold each test-tube against some dark back ground as the coat sleeve and look carefully for the slightest opalescence, especially in tube in which test (b) has been performed. Let both tubes stand for six hours and, if at the end of that time neither turbidity nor "flocks" are observed, albumin is absent; if there is a slight turbidity which, however, is cleared by reheating the tube in which test (b) has been performed, albumin is absent; if the turbidity is not cleared by heat, albumin is present in small amount.

Avoid Chances for Error.—I. See that the urine is filtered clear, by comparing the filtered urine with the original.

II. See that the turbidity occurring with tests (a) and (b) is caused by these tests: compare the filtered urine to which nothing at all has been done with the results obtained with tests (a) and (b). If the filtered urine is just as turbid as the urine to which tests (a) and (b) have been applied, the turbidity is due to improperly performed filtration.

III. See that acetic acid is added before test (b) is applied. N. B. In some few cases the urine may be intensely acid of itself, turning the blue litmus paper instantly bright red. In such cases it is of detriment to add acetic acid. Apply the heat test directly, and if a turbidity is noticed, add an abundant quantity of nitric acid, say 20 or 30 drops and boil. If the turbidity persist, albumin is present. It will very rarely be necessary to modify the test in this manner.

Notes on Manipulation.—I. In performing test (a), the nitric acid must not be poured carelessly from bottle to tube. I am in the habit of using a small glass syringe connected with a glass jet by means of a rubber tube. The nitric acid is drawn up

into the syringe, the latter taken in the right hand and the tip of the forefinger placed on the end of the piston; gentle pressure on the latter causes the acid to trickle down gradually and evenly into the urine, the end of the jet being placed inside of the test tube containing the urine. When albumin is present, a clear cut and sharply defined zone of turbidity is noticed, especially if the test-tube be held against some dark object as the coat-sleeve.

II. Before performing test (b), acetic acid is usually added, but *citric acid* may be used or a *citric acid test paper*; if the latter, let it remain in the urine for a short time before applying heat. If the urine is strongly alkaline, more than one drop of acetic acid or more than one citric acid test paper may be needed.

III. In case an alcohol lamp is not at hand, test (b) may be performed by aid of a candle. By holding the tube on the edge of the flame, smoking may be avoided.

Newer Tests for Albumin.—Some of the tests employed for the detection of albumin involve the use of potassio-mercuric iodide, picric acid, acidulated brine, acetic acid and potassium ferrocyanide. Of these, the last is preferable for many reasons; acidulate the urine with acetic or citric acids, then add solution of potassium ferrocyanide; *do not heat* but wait a few moments and if albumin be present a turbidity will be seen.

In all cases where albumin is abundant, the turbidity produced by the various tests is seen to be composed of separate "flocks" of the coagulated albumin.

Peptone is detected best by the potassio-mercuric iodide solution or by picric acid; care should be taken to "float" the urine on the surface of the reagent, that is, having introduced some of the potas-

sio-mercuric iodide solution into a test-tube, cause an equal amount of urine to flow down the side of the tube; if peptone is present, a zone of turbidity will be noticed at the juncture of the two fluids; *it should clear on application of heat.* *Urates* complicate this test, so, in order to decide which of the two it is, float some urine on some of Fehling's solution (described under Sugar); a rosy red color at the juncture indicates presence of peptone.

Bedside Testing for Albumin.—As strong acids are not desirable in the sick room, try test (b) only, using a citric acid paper or two for acidulation and a candle or gas flame for heat. (See description of Pocket Case for Urinary Analysis.)

Estimation of the Quantity of Albumin.—The following is a rough but useful *approximate quantity* test: boil a given quantity of the urine in a test-tube—with a drop or two of acetic acid, if alkaline; set aside for five or six hours. The precipitated albumin sinks and forms a layer of varying thickness. The proportion of albumin is estimated by the depth of this layer as compared with the height of the column of urine, and may be expressed in numbers as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{10}$, etc. If too little albumin is present to form a layer, call it "cloudiness" or "opalescence." The urine should first be filtered and a graduated tube used if possible. Use either a sample of the twenty-four hours' urine for each estimation, or urine voided at the same hour, or thereabouts, daily.

[A convenient quantitative method—that of Esbach—will be found fully described in the "Manual of Simple Tests, Part II." Roberts' method is also convenient and is here described.]

Dr. Wm. Roberts estimates albumin *by dilution*, as follows: take a clean glass jar capable of holding 2,000 or 3,000 Cubic centimetres of fluid; into

this place five Cubic centimetres of the albuminous urine and dilute it with five Cubic centimetres of clear water. This dilution may be termed the "first degree"; add to it some nitric acid, a few drops. If cloudiness occurs, again add another five Cubic centimetres of water, and again, if necessary, test with nitric acid; this second dilution forms the "second degree." And continue in this manner until the acid occasions no reaction after the liquid has stood for thirty seconds, but occasions a faint opalescence at the forty-fifth second; this is the zero point of the reaction. Now divide the number of the dilutions, or degrees required, by 5 (the number of Cubic centimetres of urine used to start with), which will give "the degrees of albumin," each degree of which he has ascertained by calculation to be an indication of .0034 per cent of albumin in the urine tested. Suppose 1200 Cubic centimetres of urine to be passed in the twenty-four hours, five Cubic centimetres of which required 1250 dilutions before the zero reaction was attained; then $1250 \div 5 = 250 \times .0034 =$ .85 per cent of albumin; 1200 Cubic centimetres multiplied by .85 equals 10.2 grammes of albumin in this urine of twenty-four hours.

Clinical Significance of Albuminuria.—The term "abnormal constituent," with reference to albumin, is used notwithstanding the observations of many who have found a small amount of albumin in the urine of healthy individuals. For instance, Senator, of Berlin, examining the urine of himself and three colleagues, found traces of albumin occurring every now and then at different times in the day. Frerichs, J. Vogel, Ultzmann, De Mussy, Leube, Gull, Edlefson, Marcacci, Munn, Bull, Fuerbringer, and others, have recorded cases of a similar nature. The routine practitioner is not likely to be greatly puzzled by finding albumin for which he can

not account, since the so-called "normal albumin" occurs in very small amount and is not likely to be noticed by one making a hurried test and having little experience in chemical manipulations. Any one interested in the subject will find its literature given by Dr. Ellis, of Harvard Medical College, in the *Boston Medical and Surgical Journal*, as well as an interesting paper and discussion in the report of the stated meeting of the New York Academy of Medicine for Dec. 15, 1881, and a long chapter in Senator's monograph, *Die Albuminurie.*

Transitory albuminuria has been noticed after injury to the skull. (Peabody.) After drinking a pint of milk. (Smith.) After external applications of iodine. (Bouchut.) After inhalations of turpentine. (Emerson.) After persistent albuminous diet. After excessive smoking of cigarettes. (Bradley.) After poisoning by oxalic acid. (Silk.) After inunction with Goa powder ointment. (Israel.) After use of iodoform dressings. (Zeissl.)*

Diseases, etc., not Bright's, in which Albumin may be Found in the Urine.

I. Diseases in which notable diminution of oxidation follows a difficult respiration: croup, laryngeal diphtheria, ascites, emphysema with much dyspnœa, pulmonary phthisis (especially if complicated with pneumonia and there is great difficulty of respiration), pregnancy and the puerperal state.

II. Cyanosis: heart troubles, where there is partial asphyxia.

III. Eclampsia.

IV. Cholera.

V. Idiopathic or traumatic lesion of nerve centers, with lowering of temperature and notable diminution of combustion.

*According to Kocher, acute nephritis may follow the use of iodoform dressings.

VI. Diabetes.

VII. Curvature of the spine.

VIII. Natural or artificial suppression of cutaneous perspiration: measles, scarlet fever, small-pox; also after intense cooling of surface of body, as in a cold bath.

IX. Septicæmia, hospital gangrene, phlegmonous erysipelas, yellow fever, typhoid fever, typhus.

X. Miliary sweat, jaundice, chlorosis.

XI. Gout, red gravel, rheumatism.

XII. Cachexies: syphilis, cancer, malaria, scrofula.

XIII. Febrile and inflammatory diseases in general: zymotic diseases, peritonitis, traumatic fever, meningitis, etc.; inflammatory affections of the skin: anthrax, furuncle, erysipelas, burns.

XIV. Diseases due to hydræmic condition of blood with atony of tissues: purpura, scurvy, pyæmia, etc.

XV. Nervous prostration from grief.

XVI. Impediments to the circulation: abdominal tumors, cirrhosis, etc.

XVII. Temporarily, after excretion of irritating substances, as balsam copaiba, turpentine, cubebs; of concentrated, highly acid urine; of oxalate of lime and sharp crystals of uric acid.

XVIII. Temporarily, after various vascular contractions: convulsions, epileptic and intermittent fever paroxysms.

Drugs causing the Appearance of Albumin in the Urine:—I. Anæsthetics, among them chloral hydrate.

II. Many emetics and cathartics, especially *drastic* cathartics.

III. Potassium nitrate.

IV. Coffee (sometimes).

V. Fuchsin, especially *arsenical fuchsin.*

VI. Various metallic salts: the mercurials, soluble compounds of antimony and lead, some salts of silver, and of cadmium, uranium nitrate, salts of copper, the arsenicals, chloride of gold and platinum,

VII. Poisoning* from arseniuretted hydrogen, carbon monoxide and dioxide, phosphorus, iodine, potassium iodide, carbolic acid (sometimes).

The injection of water into the veins may produce albumin in the urine.

Albumin is more often found in the urine of those who live in high altitudes than in that of those who live in low countries.

The following points in regard to the appearance of albumin in the urine are of particular importance:

(i.) In diphtheria, albumin in the urine appears *early* in the disease, an occurrence which is deemed of diagnostic significance.

(ii.) If albumin occur in the urine of a pregnant woman, look for *casts* (with the microscope) and other evidences of renal disease. Since puerperal eclampsia is often accompanied by parenchymatous nephritis, i. e., inflammation of the substance of the kidney—the mere presence of albumin *alone*, without other signs of kidney disease, is not necessarily alarming.

(iii.) If the urine contains leucorrhœal discharge or spermatic fluid,† albumin may be found due to their presence and no kidney disease is *necessarily* present.

(iv.) A pale, dilute urine abundantly albuminous is more indicative of Bright's disease than a dense, high-colored urine with less albumin, which is more

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*Prof. Wood reports albumin and casts in urine of patient who had been taking heavy doses of salicylic acid.

†It is said that *serum* albumin is not found in urine containing spermatic fluid.

likely to be indicative of pyrexia or of some impediment to the circulation of the blood.

(v.) If pus or blood be found in the urine, see next paragraph.

False Albuminuria.—When the urine contains pus or blood, a not large amount of albumin is likewise found; this is the albumin of the blood or of the pus since both of these substances contain it; to get an idea of about how much albumin belongs to pus, add to normal urine some pus from a suppurating wound and after allowing the sediment to form, apply the usual albumin test.

This condition is termed *false albuminuria* and is found in diseases of the excretory passages and bladder, as,

(i.) Cystitis.
(ii.) New growths in the bladder.
(iii.) Stone in the bladder.
(iv.) Prostatitis and hypertrophy of prostate.

Again there are diseases in which besides pus and blood, more albumin occurs in the urine than the pus and blood will account for; these are diseases of the kidney-pelvis—pyelitis in its various forms; hemorrhage from the kidney may be accompanied by more albumin than the blood will account for.

Bright's Disease.—Albumin is found in the urine of the various Bright's diseases, accompanied generally by abundant casts, renal epithelium, and fatty cells, by the presence of which they can be differentiated from simple hyperæmia, febrile hyperæmia, renal stasis proper, and false albuminuria.

Vulpian has noticed that in Bright's diseases the albuminoids in the saliva are augmented.

In Bright's disease the albumin in the blood is diminished.

Summary.—Sir Henry Thompson makes the following observation in regard to albumin in the urine:

"whenever clear urine of acid reaction, free from blood, contains a notable amount of albumin, such albumin is usually of renal origin.

An important aid in the diagnosis of the Bright's diseases, is knowledge of the daily amount of urine passed. "In only an exceedingly small percentage of the cases in which I examine the urine I am able to learn, approximately, how much the patient is passing," says Prof. E. S. Wood, of the Harvard Medical College; "in private practice measurement of the urine, in cases of known or suspected renal disease or complication, is the rare exception.

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"It is no hardship to require actual measurement of the urine in case of patients who are not confined to the house, since they can be provided with a wide-mouthed bottle fitted with a tight stopper and sufficiently large to contain the amount passed at a single micturition. This bottle can be graduated into twenty-five or fifty Cubic centimetre spaces or into fluid ounces, by a file mark on the glass or by marks on a strip of paper pasted on the outside. This may, if necessary, be carried in the pocket, and the amounts passed at each micturition be noted * * * in acute parenchymatous nephritis the amount is at first much diminished, and then gradually increases with each diminution of the inflammation up to the normal amount; with convalescence it exceeds the normal considerably; and finally, in those cases which terminate in recovery with complete restoration of the kidney to a healthy condition, it falls again to the normal.

"In chronic parenchymatous nephritis the amount of urine is always below normal, any increase above normal rare or temporary. With the increase of the disease accompanied by increasing dropsy, the amount is very small and the urine concentrated;

but when the progression is not active the amount is but little below normal.

"In both interstitial nephritis and amyloid degeneration the amount of urine is largely increased, even to three and four times the normal amount except during a short time previous to death, when the quantity may be less than normal. In complicated cases which are far more common than uncomplicated ones, the amount of urine varies according to the nature and extent of the complicating affection. * * * The result of the admixture of chronic or acute parenchymatous nephritis with either the interstitial or amyloid degeneration, is to diminish the amount of urine, and the amount of this diminution is dependent upon the extent of the parenchymatous complication. * * * *

"If a parenchymatous affection exists as a complication of either an interstitial nephritis or an amyloid degeneration, it is almost sure to be detected by the increased amount of albumin and the character of the sediment; the measurement of the amount of urine is often in these cases of especial importance in making a diagnosis of such complications. If, for example, we have a specimen of urine with hyaline, granular, and fatty renal epithelium in the sediment, and at the same time the urine contains a considerable amount of albumin, it is impossible for us to say whether it is a case of pure chronic parenchymatous nephritis, or one of the other forms of Bright's disease in which the parenchymatous affection is merely a complication; but if we knew that the daily amount of urine averaged between 2000 and 3000 cubic centimetres, we might be reasonably sure that the parenchymatous disease was not the principal one but only a complication. If the parenchymatous affection is the principal one, the amount of urine will be diminished,

in which case it is impossible without the history of the case, to determine the existence of any of the other forms of organic renal diseases.

"It is well known that Bright's disease is diagnosticated chiefly by the detection of albumin in the urine and renal casts in the urinary sediment, and I frequently meet physicians at the present time who pronounce the existence of serious organic renal disease from these characteristics alone, which may occur without serious disease of the kidney. Daily measurement of the urine in these cases is of very great assistance. In hyperæmia of the kidneys, for instance, due to disease or abnormal condition of some other organ, we frequently find both albumin and casts, and a knowledge of the amount of urine may prevent an error in diagnosis and prognosis. In passive hyperæmia of the kidneys, due to cardiac or other disease we find in the urine, so far as the kidneys are concerned, only hyaline and finely granular casts and a trace of albumin—conditions which are only found in the interstitial and amyloid forms of Bright's disease; but the average daily amount of urine in passive hyperæmia is diminished, while in the above mentioned organic diseases it is much increased.

"In active hyperæmia of the kidneys, due to the elimination of some virus or drug, the amount of urine is usually diminished, owing to the febrile complication, and in addition to the sediment mentioned above in cases of passive hyperæmia, we find free blood and renal epithelium and usually an occasional blood and epithelial cast; albumin is present only in mere traces.

"These characteristics of the urine and sediment are the same as those of acute nephritis, but in the proportion in which they occur in the stage of convalescence, when in acute nephritis the amount of urine

is increased, and often much increased, while in this condition of hyperæmia it is almost always diminished. * * *

"I have known a diagnosis of chronic Bright's disease to be made in a case of cerebral disease, in which the urine contained a trace of albumin and the sediment hyaline casts with blood and renal epithelium, yet the amount of urine was about normal and more than fifty grammes of urea were being eliminated—a condition of things which should lead one to give at least a doubtful diagnosis, so far as the kidneys are concerned, and to wait for time to show whether a temporary or a permanent affection existed. In this case the casts and albumin have entirely disappeared.

"In typhoid, rheumatic, and other fevers we often see in the urine a few hyaline casts and a trace of albumin, with a diminished amount of urine. In these cases parenchymatous disease of the kidneys can be eliminated by the character of the sediment, and the proportion of albumin, and the same composition of the sediment can only be eliminated with absolute certainty by waiting until the fever has subsided and examining again, although a normal or increased amount of solids, with the diminished amount of urine points very decidedly to the absence of any serious renal disease.

"In many cases of acute rheumatism, especially after the exhibition of salicylic acid and the salicylates I have found a trace of albumin in the urine, and hyaline and finely granular casts with blood and renal epithelium in the sediment. * * * I have seen some of these cases in which the casts and albumin entirely disappeared, but in which the diagnosis of chronic Bright's disease had been made; an error which would not have occurred had due regard been paid to the amount of work which the

kidneys were capable of doing and to the average daily amount of the urine."

In rare cases of Bright's disease albumin may disappear from the urine in the course of the disease; it is often the case that it diminishes in amount.

Hints for Diagnosis of Bright's Disease.—Urine permanently albuminous, when neither pyrexia, thoracic disease, nor other condition exists which may account for the presence of albumin, is likely to indicate organic disease of the kidney. If an abundant deposit containing *casts* and much *renal epithelium* or numerous casts and cells in a state of fatty degeneration be also found, the proof is almost positive, if due regard to the *quantity* of urine and to the amount of urea excreted, be paid.

The lower the specific gravity in kidney troubles the more serious the case, as a rule.

CLINICAL SUMMARY.—Albumin.—A notable amount of albumin occurs in the urine of (1) many acute diseases, (2) Bright's disease, (3) pregnancy and the puerperal state, (4) after the administration of, and in poisoning by, various drugs.

(*a.*) In cases of pregnancy, where albumin is found in the urine, examine the deposit with the microscope for *casts* and other evidence of renal disease—mere presence of albumin without casts, etc., is not necessarily alarming.

(*b.*) A pale, dilute urine abundantly albuminous is more indicative of Bright's disease than a dense high-colored urine with less albumin; the latter is more likely to be indicative of pyrexia or some impediment to the circulation. In cases of suspected Bright's disease observe (1) quantity of urine in twenty-four hours, (2) albumin, (3) tube casts, epithelia, etc., in the deposit, using the microscope.

(*c.*) In diphtheria, albumin may be found in the urine early in the course of the disease.

(*d.*) If the urine contains pus, blood, or leucorrhœal discharge, then albumin corresponding to the same, may be found.

(*e.*) In case albumin only without pus, blood, casts, etc., be found, the condition is probably one of functional albuminuria rather than organic disease, provided the quantity of urine, etc., is not greatly changed.

(*f.*) The urine of women often contains albumin in traces, due to purulent contamination. A cleansing injection should be taken before voiding urine for examination.

(*g.*) During pregnancy attention must be paid, not merely to presence of albumin, but to the *quantity* of it. A large quantity is an unfavorable sign, and when found, the urine of twenty-four hours should be measured daily. A gradual falling off in the total quantity of urine voided daily is unfavorable as a sudden decrease in quantity followed by convulsions may take place when not expected.

Detection of Sugar.—If the urine contains a *plentiful amount* of sugar a simple and convenient clinical test is the following: add an equal amount of a freshly-made solution of potassa (specific gravity 1060) to the urine and, holding the lower closed end of the test-tube between the thumb and forefinger, heat the urine in the upper part of the tube to boiling; if sugar be present the heated portion will be colored yellow, then brown-red (or even dark purple if a large quantity of sugar is present,) while in the non-heated part of the tube the urine does not change its color. Addition of a little nitric acid causes an odor to be given off somewhat resembling that of molasses. A whitish, flocculent precipitate of phosphates should not be mistaken for a reaction of sugar, in applying this test. In case the above test gives an unsatisfactory or doubtful result

the practitioner should by all means try Fehling's test liquid or some of its modifications.

Fehling's solution is made as follows: dissolve 34.64 grammes pure crystallized sulphate of copper. free from iron and moisture, in 200 Cubic centimetres of distilled water. 173 grammes of Rochelle salt are next disolved in 480 cubic centimetres of caustic soda solution (specific gravity 1.14) and to it the copper solution previously made is added, and the whole diluted with distilled water to exactly one litre. Heat to boiling, in a good sized test-tube, 10 cubic centimetres (2.7 fluidrachms) of the solution, previously introducing a few small fragments of clay tobacco-pipe to prevent bumping, *i. e.*, spasmodic boiling. When boiling, add $\frac{1}{2}$ to 1 Cubic centimetre (8 to 16 drops) of the urine which has been previously treated as follows: albumin, if present, removed by heating the slightly acid or acidified urine to boiling and then filtering from any precipitate. Next (or—if the urine contain no albumin—*first*,) rendered distinctly alkaline by addition of caustic soda solution, filtered from any precipitate of phosphates, etc., and finally added to the boiling Fehling solution, in amount $\frac{1}{2}$ to 1 Cubic centi metre, as specified above.

If sugar be abundant as in a decidedly diabetic urine, a yellowish or brick-red opacity and deposit will be produced. If a doubtful reaction is obtained, test for traces of sugar by adding 7 or 8 Cubic centimetres of the urine to the hot liquid, heating again to ebullition and then setting the tube aside for some time. If no turbidity is produced as the mixture cools, the urine is either free from sugar or at any rate contains less than 0.025 per cent. If the quantity of sugar present is small—that is under 0.5 per cent.—the yellow or red precipitate does not takə place immediately, but occurs as the liquid cools, the appear-

ance being somewhat peculiar. The liquid first loses its transparency and passes from a clear bluish-green to an opaque, light-greenish color. This green, milky appearance is quite characteristic of diabetic sugar.

Care should be taken not *to boil* the mixture long after the urine has been added to it; prolonged boiling will cause a reduction of the copper solution by urates, especially if the latter be in excess.

The test given above is recommended by Allen, of Sheffield; several circumstances must be noted in applying it. I. Fehling's solution, made as described, undergoes certain obscure changes on exposure to air and light, hence it is better to prepare this solution in two parts, namely, (*a*) 500 Cubic centimetres of the Rochelle salt solution and (*b*) 500 Cubic centimetres of the sulphate of copper solution. This may be done by adding water to each solution separately until each amounts to 500 Cubic centimetres, rather than adding enough water after the two have been mixed, to make 1,000 Cubic centimetres or 1 litre, as directed previously. Instead, therefore, of mixing the copper sulphate solution and the Rochelle salt solution, keep them in separate bottles and mix in equal volumes only when used. Thus, if according to direction, 10 Cubic centimetres of Fehling's solution are required, add 5 cubic centimetres of the copper solution to a like amount of the Rochelle salt solution. II. Much of the Rochelle salt of commerce is impure; the safest method of preparing it is as follows: dissolve commercial cream of tartar in hot water, adding carbonate of sodium till the liquid remains slightly alkaline after boiling, filtering from the precipitated calcium carbonate and crystallizing the Rochelle salt from the clear liquid. III. Too much importance must not be laid upon detecting traces of sugar since normal urine often contains small amounts of this substance.

Estimation of Sugar.—The simplest method of determining the quantity of sugar in urine is the "differential density fermentation test" which is performed as follows:

a. Pour four fluid ounces of urine into a twelve ounce bottle;

b. Next add a lump of German (condensed) yeast the size of a chestnut;

c. Find a cork that does not fit the bottle well and loosely cork the bottle with it;

d. Set the bottle in a warm place; some authors suggest the "mantel-piece," evidently forgetting that the rage for bric-a-brac has now wholly subsided;

e. Now find another twelve ounce bottle and pour into it four fluid ounces of the same urine;

f. Find a cork that fits it *very tightly*, cork and set side by side with loosely corked bottle "No. 1," being careful *not to add any yeast* to tightly corked bottle "No. 2;"

g. Next allow twenty-two hours to elapse and then remove both bottles to a cool place and let them rest two hours more;

(*h.*) Procure two breakers or cylindrical vessels and at the expiration of the two hours pour the contents of bottle No. 1 into one breaker and those of No. 2 into the other;

(*i.*) Take the specific gravity of each with the urinometer; the specific gravity of the urine in bottle No. 1 will be less than that of the urine of bottle No. 2, owing to fermentation in No. 1 caused by yeast, having changed the sugar into alcohol and carbolic acid; the latter substance, being a gas, escapes;

(*j.*) Subtract the specific gravity of the urine of bottle No. 1 from the specific gravity of the urine of bottle No. 2, and the difference is grains of sugar to the fluid ounce of urine.

For instance, suppose the specific gravity of the urine in bottle No. 1 is 1020, and that of bottle No. 2, 1040; 1040 less 1020 equals 20. This signifies that the urine contains 20 grains of sugar to the fluid ounce of urine; the urine for twenty-four hours, of which the urine examined has been a sample, having been measured is, say, 100 ounces; then 100×20 will give the total amount of sugar in grains for the twenty-four hours, viz., 2000 grains.

Estimation by use of Polariscope.—Dr. F. R. Cruise of Dublin recommends the use of the Yvon-Duboscq diabetometre which has been shown by Tichborne, Chemist to the Apothecaries' Hall of Ireland to be entirely satisfactory. It is also approved of by Stephen Yeates. The fundamental principle upon which the polariscope depends, as a means for determining the existence and amount of sugar in a given solution, is the well-known fact that a saccharine fluid always *rotates* polarised light, and that the amount of rotation is in *exact proportion* to the density of the solution. The Yvon-Duboscq instrument belongs to the class of "half shade" polariscopes. (See Landolt's handbook of the Polariscopes for further information). In using the instrument the new position of the disc, turned until the two halves are *perfectly evenly lighted*, points out the amount of rotation—or in other words records the amount of sugar in the urine, each division of the disc representing one gramme of sugar to the litre*.

Detection of Albumin and Sugar when together.—When it is desired to test urine for sugar, which is suspected, or has been found to contain al-

*Extract from a paper kindly sent me by the author, Dr. F. R. Cruise, President of the King and Queen's College of Physicians, in Ireland. The Yvon-Duboscq diabetometre, with full instructions and needful appliances, can be had from Messrs. T. & A. Duboscq, 11 rue des Fosses, St. Jacques, Paris.

bumin, proceed as follows: Take the reaction, and if alkaline, add a drop of or two of acetic acid—otherwise not—boil thoroughly and the albumin will be precipitated. Let the urine remain at rest until the albumin has settled to the bottom of the tube, then pour off carefully the supernatant urine and test it for sugar by any of the methods previously mentioned.

Clinical Significance of Sugar in the Urine.—The sugar which is found in urine is not cane sugar, but more closely resembles grape sugar or glucose, hence the term glycosuria.

Sugar in the urine may often be found when the patient has not diabetes mellitus, but the latter malady seldom exists without sugar in the urine. Sugar may appear in the urine as a result of the following diet: immoderate use of starchy and saccharine food; generally the amount of sugar in such cases is very small *but occasionally large amounts have been known to appear.*

Diseases, not Diabetes Mellitus, in which Sugar may appear Temporarily in the Urine:

(I.) Cerebral disturbances, or those of the nervous system in general, especially of the medulla.

(II.) Disturbance of various bodily processes: diminution of respiration and absorption of oxygen: excessive production of sugar by the liver; diminution of the alkalies in the blood.

(III.) Pregnancy and child-bed.

IV. Plethora, especially of women at menopause.

V. Old age.

VI. Skin diseases: suppurative stage small-pox, suppurations generally, eczema of the genitals.

VII. Tetanus rheumaticus and intermittent fever (temporarily).

VIII. Various disorders: hepatic or gastric troubles, typhus, malarial fever (6 to 8 grammes to

the 1000 Cubic centimetres of urine at most), pneumonia, acute febrile processes.

IX. Convalescence from cholera, rougeola, and erysipelas, (amount small).

X. In various diatheses: phthisis, syphilis.

XI. Rheumatic gout and rheumatism; if the gout becomes *atonic* danger of diabetes mellitus.

XII. Gangrenous and ulcerative processes: uterine ulcers, severe burns.

XIII. After paroxysms of whooping cough, asthma or epilepsy.

XIV. After miscellaneous mishaps: blows in the epigastrium, disordered digestion, intense grief, sudden mental shock, exposure to cold, hereditary influence.

Agents which may cause Sugar to Appear in the Urine:

I. Oil of turpentine.

II. Chloral hydrate and various anæsthetics.

III. Nitro-benzol.

IV. Carbonic oxide gas (poisoning from).

V. Amyl nitrite.

Diabetes Mellitus.—In diabetes mellitus large amounts of sugar may be persistently present in the urine; the flow of urine is enormously increased, there is emaciation, great thirst, etc., in typical cases. If the urine of a patient *persistently* contain sugar, while at the same time other well-known symptoms are present, there is reason to fear diabetes mellitus. In rare cases sugar may be absent.

Diet which Increases Sugar in the Urine (to be avoided by Diabetics):

All substances containing sugar: sugar, syrups, preserves, sweet wines, champagne, beer, cider; fruits containing sugar, as raisins, figs, bananas, pine-apples, melons; farinaceous foods, as bread, pastry, dumplings, rice, macaroni, vermicelli, tapi-

oca, potatoes, carrots, lentils, kidney beans, etc. (Hardy.)

Diet which does not Increase Sugar in the Urine: (to be used by diabetics):

Bouillon, cabbage soup, bisque soup, game, fish, poultry, string beans, spinach, asparagus, tea and coffee with glycerine instead of sugar; slightly acid fruits, peaches, cherries, currants; Bordeaux and Burgundy wines, red wines; alkaline mineral waters (in *early stages* of the disease).

The *amount* of urine in diabetes mellitus may vary from eight to fifteen pints, occasionally *over thirty* pints; the *specific gravity* is generally very high, 1030 to 1052, generally about 1040; the *color* is likely to be pale, the *odor* faintly agreeable, like that of new mown hay; the urine *froths* readily when poured from one glass to another.

The urine is itself generally clear and its taste to the connoisseur is sweet.

When the excretion is considerable in amount, exceeding four or five pints, the color may be described as a pale straw tint and the aspect of the urine is noticeably bright, but where the quantity passed is less than this, the ordinary color obtains; the average quantity of sugar passed daily ranges from 15 to 25 ounces, although more than *two pounds* have been observed.

If the quantity of sugar is large, a sweetish, wheylike odor is noticed; sediments are rarely observed in diabetic urine. (See however Fungi).

Freshly passed diabetic urine is usually neutral or alkaline but soon becomes strongly acid owing to fermentation; if a bottle be filled with diabetic fermentation; if a bottle be filled with diabetic urine, corked and set in a warm place, so much carbonic acid gas may be generated as to blow out the cork. Cloths soaked in diabetic urine, when dried become sticky and look as if they were coated with honey.

Albumin and Sugar Together.—Th. Frerichs finds albumin occurring together with sugar under three conditions:

I. Glycosuria.

II. Diabetes mellitus.

III. Chyluria.

Albuminuria is a frequent complication of glycosuria, according to Frerichs, occurring in fifty per cent. of such cases.

Glycosuria may occur in the course of acute and chronic cerebral affections, and with it Frerichs found albuminuria in (1) aneurism of brain rupturing into ventricles, (2) extensive apoplectic effusions, (3) purulent general meningitis, (4) chronic tubercular basilar meningitis.

In acute cases the prognosis is occasionally favorable, most so in meningitis, but in chronic cases unfavorable as a rule. Nephritis rarely complicates diabetes mellitus—in five per cent. only of the cases observed by Frerichs. All cases of diabetes mellitus complicated with phthisis and albuminuria terminated fatally; others where the albuminuria depended on cystitis and subsequent nephritis ended in recovery. In chyluria (chyle in the urine) albumin, sugar and fat may be found in the urine.

CLINICAL SUMMARY.—Sugar *persistently* present in the urine of high specific gravity, in connection with the well-known symptoms of hunger, thirst, emaciation, etc., indicates diabetes mellitus.

Sugar *temporarily* present in urine may not necessarily indicate diabetes mellitus, but if often found should at least cause the patient to take certain precautions regarding diet, hygiene, etc.

Detection of Bile Coloring-Matter.—Fill a test-tube half or two-thirds full of urine and allow 20 or 30 drops of red nitric acid (commercial nitric acid which has been exposed to the sun's rays) to trickle slowly

down the side of tube held inclined. At the juncture of the urine with the acid a play of green and blue colors will be seen, especially if the tube be held before some white object, as the wall.

This test is not always successful. The urine should be freshly voided.

The presence of bile *coloring-matter* in the urine is of slight clinical importance; it may be found in the urine of (1) icterus, (2) phosphorus poisoning and (3) after severe burns.

Urine containing bile pigments is richly colored, deep brown, reddish brown, greenish brown, dark green or grass green; it foams strongly on being shaken and colors unsized paper yellow or greenish.

Bile-acid salts are found sometimes in the urine. Dr. Oliver has devised a test for them and has done much to explain their significance. (See "Bedside Testing," by Oliver.)

CHAPTER III.

SEDIMENTS OR DEPOSITS.

The terms *urinary sediment*, *urinary deposit*, are used to describe the various substances precipitated from urine (in which they are held in solution or suspension) when this fluid is at rest for a longer or a shorter time.

Normal urine on standing shows a light, scarcely visible cloud; when, however, a plainly visible turbidity is seen which, as the urine stands, shows a tendency to form a sediment, it is necessary to examine the same with a view to ascertain the constituents of the deposit and their clinical significance.

Beale divides deposits into three classes:

I. Light, flocculent, transparent, voluminous deposits: mucus and epithelium, spermatozoa, vibrions, fungi, casts.

II. Dense, opaque, bulky: urates, pus, phosphates.

III. Granular or crystalline, small bulk, sinking to bottom or deposited on sides of the urine glasses: uric acid, calcium oxalate, triple phosphate, cystin, lime carbonate, blood corpuscles.

N. B.—A very thick, glairy, gelatinous deposit is pus altered by the action of ammonium carbonate.

The distinction between the first two classes is easily made, inasmuch as urates, pus, and phosphates, Class II, soon sink to the bottom of the urine glass, leaving a stratum of clear urine above them, whereas the constituents of Class I are so light as to require a long time for settling, and even then, the supernatant urine will not be as clear as in case the

deposit were of Class I. The essential characteristic of deposits of Class III. is their very small bulk compared with that of the others.

By noticing to which of these three classes a sediment seems to belong, the physician may gain considerable time in his chemical or microscopical examination of them.

The order in which the constituents of sediments will be described is as follows:

Urates,	
Uric acid,	
Calcium oxalate,	Unorganized sediments.
Phosphates,	
Fat,	
Blood,	
Pus,	
Mucus,	
Epithelium,	Organized sediments.
Casts,	
Spermatozoa,	
Fungi,	
Entozoa.	

Method of Recognizing the Constituents of a Deposit.—Ascertain as nearly as possible to what class (mentioned above) the deposit belongs, next apply chemical tests and verify with the microscope if necessary.

NON-ORGANIZED DEPOSITS.

Recognition of an Urate Deposit.—Let the urine settle, pour off the supernatant liquid, pour some of the sedimentary urine at the bottom into a test-tube, heat (*not to boiling*, lest any albumin present be precipitated,) and if the urine *clears* the presence of a urate deposit is indicated. Stand the test-tube aside and if, on cooling, the urine becomes turbid again the correctness of the conclusion is veri-

fied. There is a rumor afloat that the practitioner sometimes mistakes urates for albumin; urates are a *deposit* in the urine clearing on the application of gentle heat—albumin is never a deposit in urine but coagulated by heat a little below the boiling point; in other words, gentle heat causes the urates to *disappear*, boiling heat, albumin to appear. Suppose then the urine contains a sediment of urates and albumin—gentle heat will cause the urate deposit to disappear and the urine to become comparatively clear, but further heating will now cause a turbidity due to the presence of albumin, and, if the boiling point is reached, the urine will become persistently cloudy. The microscope is not indispensable for the recognition of urate deposits as distinguished from others, but it is worth while to know whether the urates themselves are amorphous (non-crystalline) or crystalline. If a deposit, which by chemical means has been ascertained to contain urates, be examined with the microscope, the appearance, if the urates be amorphous (non-crystalline), is that of irregular particles or granular powder; in rare cases the so-called "hedge-hog" crystals of sodium urate may be seen (Fig. 5). If seen in *stale* urine prismatic crystals arranged in star-like masses may be noticed, which are of no clinical import.

Clinical Significance of Urate Deposits:

Patients often complain of a "brickdust" sediment in the urine, and this lurid deposit causes them much uneasiness, suggesting by a logical (?) process the presence of the terrible destroyer "Bright's disease;" practitioners having "the wisdom of a serpent" should thoroughly appreciate the fact that *occasional* "brick-dust" sediments are as "harmless as a dove;" they may be due to one or more of the following:

Causes of an Occasional Brick-Dust (Amorphous Urate) Sediment in the Urine:

I. Over-eating or drinking; also prolonged abstinence from food and drink.

II. Great exertion, revelry or excitement.

III. Hard study.

IV. Fright.

V. Change in the manner of living; getting out of a warm bed into a cold room.

VI. Profuse perspiration with diminution of amount of urine.

A *frequent* or *persistent* "brick-dust" sediment should on the contrary receive most careful attention from even the busiest practitioner.

Diseases in which Urates are Deposited in the Urine:

I. Febrile disturbances; "colds," fevers, inflammatory diseases: here we may include pulmonary emphysema, ordinary fevers, capillary bronchitis, diphtheria, dysentery, influenza, intermittents (febrile stage), nephritis, scarlet fever, (at eruption) tetanus, acute polyarthritic rheumatism, after severe burns, etc.

Diseases in which Urates may be Steadily Deposited in the Urine:

I. Non-inflammatory disorders: (1.) chronic affections, heart, liver, spleen; (2.) digestive disturbances in children (milky white urates); (3) incipience of gravel or calculus.

"The presence of uric acid and of urates in the urine in form of deposits is one of the most constant signs of functional derangements of the liver."

In a word, then, sediments of urates of pathological import usually occur in febrile states, or febrile exacerbations of chronic diseases; in such cases we find as a rule, a diminished amount of urine, of strongly acid reaction; the color of the sed-

iment may vary from clay to brick red, rose red or cinnamon; the richer the color the more the evidence of functional organic derangement; the paler the color, the worse, usually, the condition of cutaneous functions. Blows in the region of the kidneys, fatigue or congestion of these organs due to local causes, may cause urate deposits which, if occurring *in the bladder* tend, of course, toward formation of stone. In most cases where urates are *steadily* deposited and no febrile nor inflammatory symptoms are present, incipient gravel or calculus is indicated and, usually, disease of some abdominal organ is likely at the same time to exist.

The urates of which we have been speaking thus far are the amorphous or non-crystalline, but occasionally in gout and in some febrile attacks, especially of children, when the urine is scanty, high-colored of high specific gravity, and long retained in the bladder, the *crystalline* sodium urate (Fig. 5) may be found. "This substance being precipitated within the urinary renal passages is an unwelcome visitor, irritating, as it may, the mucous membrane of the bladder and urethra with its bristling crystals; it has been known to occlude the urethra with impacted masses of its deposit and the frequency of vesical calculi in children may possibly be due to the occurrence of this deposit."

(In examining urate deposits microscopically always procure fresh urine, not over a day old, since various forms of crystalline urates may be deposited at the end of acid fermentation and at the beginning of and during alkaline).

Ordinary amorphous urates appear as irregular particles of granular powder; to distinguish them from amorphous calcium phosphate, add acetic acid —the phosphate is dissolved but the urates gradually turn into *uric acid.*

Recognition of an Uric acid Deposit.—Urine depositing uric acid has, usually, a rich yellow or orange color and invariably an acid reaction. Uric acid crystals are often visible to the naked eye,

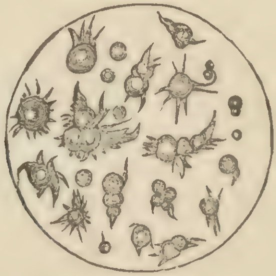

FIG. 5.

forming a film on the surface of the urine or lying scattered like brown specks on the sides of the glass, eventually subsiding into a dense red deposit resembling cayenne pepper. Urates are often associated with uric acid.

Chemical Detection.—Heat (not to boiling) a little of the deposit in a test-tube, and if it clears either partly or wholly, *urates* are present; to any residue add Liquor Potassæ and again heat gently, if any or all dissolves, *uric acid* is present. In applying this test it is desirable to separate the deposit from the urine, either by careful decantation or by filtration, as Liquor Potassæ and heat will throw down earthy phosphates normally present in urine, if any of the latter be present in the tube; the microscope affords a more rapid method of identifying an uric acid deposit.

Microscopical Appearances.—The distinctive feature of uric acid crystals is their *color* which may be red, yellow, or brown, unless by some chance they have been broken or crushed when the frag-

ments may have a whitish appearance. The higher the color of the urine the darker the crystals, and *vice versa*; if the urine be of any abnormal color, as blue or black, the uric acid crystals will be the same. Use a low power, say 100 to 200 diameters, and four-sided rhombs or "blocks" will be seen, or sometimes hexagonal plates; occasionally when seen on certain surfaces they may take the form of large stars or daggers. Fig. 6 shows the correct form which uric acid crystals may assume and Fig. 7 the occasional forms.

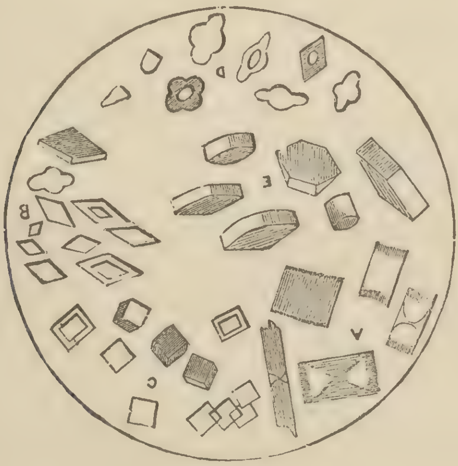

Fig. 6.

Free Uric Acid as a Sediment: Significance.—Uric acid, in a free state, i. e., uncombined with sodium, potassium, etc., is frequently found as a deposit in the urine, *normally so when the urine has entered the condition known as acid fermentation*, i. e., when twelve to twenty hours old.

Deposits of uric acid depend upon changes in the urinary secretion. (Ralfe)

Deposits of Uric Acid in the freshly-passed Urine:

I. Due to *absolute increase* in the acidity of urine: (1) occasionally in winter, action of skin checked, acidity of the urine increased and uric acid deposited: (2) eczema, psoriasis and other cutaneous disorders; (3) all forms of dyspepsia associated with irregular secretion of gastric juice. ("Acid dyspepsia."—Ralfe).

II. Due to *relative increase* in the acidity of the urine (*a.*) summer weather, when perspiration being increased, amount of urine is diminished and uric acid deposited; (*b.*) for same reason in febrile and inflammatory disorders, especially in rheumatic fever and in diarrhœa; (*c.*) alternating with appearance of sugar in the urine—sugar disappearing, uric acid is deposited, and vice versa; (*d.*) in urine of ill-nourished or strumous children caused by deficiency of alkaline phosphates.

Hints for Diagnosis.—If the deposit of uric acid occur *before the urine cools or immediately after it*, the formation of gravel or stone is to be dreaded.

If the deposit occur three or four hours after the urine is passed, gravel and stone are not so much to be dreaded.

If the deposit occur twelve to twenty hours after the urine is voided, when acid fermentation has set in, it is perfectly normal.

According to Anstie, nothing is more common in neurotic patients, without rheumatism, than a fluctuation between lithiasis and oxaluria from defective secondary assimilation of food.

In gout, uric acid and the urates are held back, but after the paroxysm, are often voided in great abundance.

Recognition of an Oxalate of Lime Deposit.—Urine depositing oxalate of lime may be (1) high

colored, or (2) of a pale greenish color, according to the conditions present. The deposit itself may be very scanty, colorless, and very like a mucus "cloud." The form of the crystals is so characteristic that no chemical test is necessary, the use of the microscope sufficing. Oxalate of lime does not dissolve in strong acetic acid and in this way may be told from the phosphates. It is insoluble in Liquor Potassæ and thus differs from uric acid.

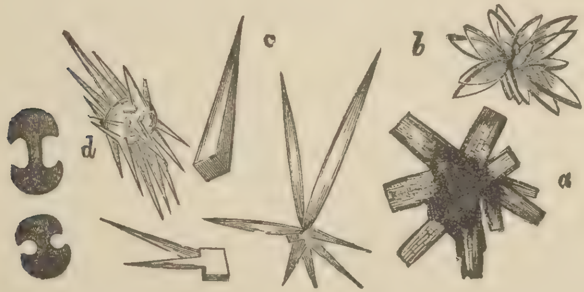

FIG. 7.

Microscopic Appearances.—The crystals are very small requiring a power of from 400 to 600 diameters to show them well, although any one familiar with them can detect them with a lower power. Their appearance is that of the rear of a letter envelope (Fig. 8) or sometimes that of a dumb-bell. They are, in the former case, octahedral in form, and very transparent; hence the focussing is sometimes difficult. They may be more readily detected by moving the slide so that the edge of the cover comes in to the center of the field; then focus clear and move the deposit. To produce lime oxalate crystals artificially, add to the urine a little lump of oxalic acid and after a few hours examine with the microscope.

Clinical Significance of Sediments of Calcium Oxalate (Oxalate of Lime).

Fuerbringer shows that oxalic acid in small quantities is a normal constituent of urine. Oxalate of lime (lime and oxalic acid combined) deposits, on the contrary, are, if *persistent*, of pathological significance. *Occasional* deposits of lime oxalate may be due to physiological causes :

I. Derived directly from food by the ingestion of substances containing oxalate of lime, as cauliflower. bananas, carrots, apples, asparagus, turnips, onions. rhubarb, garlic, tomatoes, sorrel, gooseberries, water cresses, parsnips, etc.

Persons in weak health who betake inordinately of these vegetables will often have an attack of indigestion in consequence, and lime oxalate crystals will temporarily appear in the urine.

II. Derived indirectly from food, incomplete oxidation of sugars, starches, and fats ingested.

Sugar, starch, and fat are, it is known, converted finally into carbonic acid and water in the system; any check to this process of conversion will lead to the appearance of oxalate of lime crystals in the urine; but the sediment will in due time disappear without any apparent alteration of health on part of the patient.

III. Certain drugs, as gentian, rhubarb, squill, valerian, and many others; alkaline waters, carbonated drinks, fermented liquors, sparkling wines, may be responsible, if drunk, for the appearance of lime oxalate crystals in the urine.

Diseases in which Oxalate of Lime may be Deposited in the Urine:

I. Febrile disorders.

II. Pulmonary and cardiac affections in which respiration is impeded.

III. Disorders of the hepatic functions.

IV. Depressed conditions of the nervous system.

In these disorders the urine is generally of a deep orange color, of high average specific gravity, containing excess of urea and phosphoric acid and generally turbid with mucus and urates; *the deposits of oxalate of lime are not always persistent, often disappearing for a few days to return again in great abundance.*

Besides the disorders just mentioned, oxalate of lime crystals may be found in the urine of (1) spermatorrhœa and (2) dyspepsia (certain forms).

It is to the latter of these two diseases that the term "oxaluria" properly belongs, while to the derangements associated with *uric acid* deposits the term "lithæmia" is given.

According to Ralfe the victims of oxaluria are most frequently country patients, especially those residing in damp and marshy districts or on cold, ill-drained clay soils; situations, in fact, in which catarrhal affections of the intestinal canal are likely to be engendered. The urine is usually of a pale greenish color, the quantity in twenty-four hours normal, likewise the specific gravity. Its chief characteristic is the deposit of crystals of oxalate of lime which are found most abundantly in the morning urine passed on first rising. Owing to the presence of these crystals causing irritation of the mucous membrane of the bladder, micturition is frequent and urgent, though the quantity of urine passed is not large.

Patients suffering from oxaluria experience considerable mental depression and various anomalous symptoms indicative of nervous disturbance, as burning sensation across the loins, tightness and dragging around the abdomen, shooting and burning pains in the lower limbs, twitching of certain groups of muscles, with often a feeling of numbness,

deadness and coldness. Treatment directed to the relief of the dyspeptic condition may result in improvement, enabling the physician to differentiate this disorder from early stages of locomotor ataxy.

It is very important to distinguish the *dumb-bell crystals* of calcium oxalate from the other variety; the former are, according to Beale, minute calculi. Microscopical examination of a calcium oxalate sediment is imperative.

Recognition of Phosphatic Deposit.—Urine containing a deposit of phosphates is usually of an alkaline or at most feebly acid reaction; its appearance is often "milky," and on standing, the whitish deposit settles to the bottom of the urine glass, and does not increase as the urine cools. Urate deposits are sometimes of so light a color as to be mistaken by the eye for phosphatic sediments. Phosphatic deposits are often thought by patients, lugubriously inclined, to be seminal fluid.

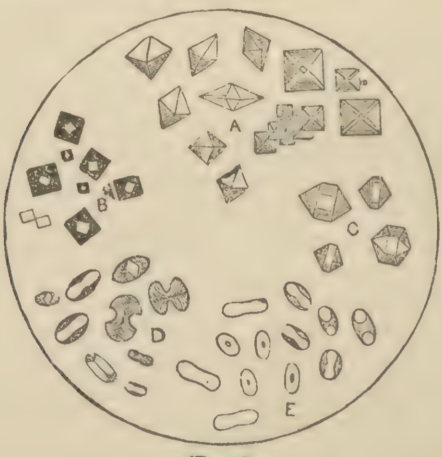

FIG. 8.

A.—Octahedral crystals of oxalate of lime. B.—The same when dry. C.—Dodecahedral crystals of lime. D.—Dumb-bells—oxalurate of lime. E.—Oval forms of oxalurate of lime.

Chemical Detection.—Heat the deposit from which most of the urine has been decanted and it does not dissolve; add a drop of nitric acid and it is dissolved. Soluble also in acetic acid.

Microscopical Appearances.—Obtain a drop from the bottom of the urine glass in which the deposit has settled and place upon a slide; if the urine be pale and faintly acid possibly the "stellar" phosphate (crystalline calcium phosphate) may be present (Fig. 9). This deposit, however, is not a common one.

FIG. 9.

Urinary deposits consisting of crystals of phosphate of lime, octahedra of oxalate of lime, with a little mucus (215 diameters).—Beale.

Usually the amorphous or non-crystalline calcium phosphate may be seen in such whitish deposits occurring in the forms of granules, roundish or oval,

with dark outlines, isolated, or else three or four united in a star-like form, or in beads, etc.; more often this phosphate shows very pale, small, transparent globules, hard to see, and always united by irregular punctated patches.

The latter form is the more common appearance; a drop of acetic acid will dissolve both forms of the amorphous calcium phosphate. (Fig. 10 D).

Ammonio-magnesium phosphate is very easily recognized; it occurs as very large, transparent crystals with sharply defined edges, generally isolated and having the typical form of a triangular prism with beveled edges, found only in alkaline urine and soluble in acetic acid. (Fig. 10 A).

It must be remembered that a deposit of phosphates does not necessarily indicate excess of the same but often merely diminished acidity of the urine.

FIG. 10.

A—Prismatic crystals of triple phosphate. B—Penniform crystals of triple phosphate. C—Stellar and foliaceous crystals of triple phosphate. D—Mixed phosphates; amorphous phosphate of lime.

A few drops of solution of sesquicarbonate of ammonia (one drachm of the salt to one fluid ounce of distilled water) added to urine passed after the digestion of a meal, will precipitate the neutral triple phosphate.

Clinical Significance of Phosphatic Deposits.—A deposit of phosphates in the urine indicates an alkaline or neutral condition of the secretion, which, if occurring after a meal or after partaking largely of fruit, carbonates, citrates, or acetates of the alkalies, is of no clinical importance. If, however, a deposit be seen daily for some little time with an alkaline reaction of the urine, examine with the microscope: if the deposit be (1) *amorphous*—i. e., containing no crystals,—nervous exhaustion, as from severe study or loss of sleep may be indicated, provided copious draughts of mineral waters had not been taken; the sediment of amorphous phosphates is also found in dyspepsia; if the deposit be (2) crystalline and consist of (*a*) calcium phosphate, it may be due merely to diet rich in lime, or else to disease of the spinal cord and chronic vesical affections; if the deposit be crystalline and consist of (*b*) ammonium magnesium phosphate, it is of considerable clinical significance if occurring in freshly passed urine.

Ammonium Magnesium Phosphate.—When the urine is alkaline from the presence of *volatile* alkali i. e., ammonia formed from decomposition of urea, we have in addition to the deposit of phosphate of lime, crystals of ammonium magnesium phosphate—"triple phosphate" as it is sometimes called. The presence, therefore, of crystals of triple phosphate when *persistent* in the urine is indicative of *local disease* of the urinary organs and not of constitutional disturbance.

Diseases in which Triple Phosphate is Deposited in the Urine:

I. Retention of urine (after).

II. Paralysis of the bladder.

III. Formation of calculus.

N. B.—A deposit of triple phosphate in stale urine, or that received into dirty chamber vessels, is of no clinical significance as regards the above three

conditions. Moreover, a *dirty catheter* may be responsible for fermentation of the urea in the urine while in the bladder, and hence triple phosphate may appear. In order, therefore, to form a correct idea of the clinical significance of this substance it must be discovered in *urine freshly passed into a clean vessel.*

Detection of Fat in the Urine.— *Chylous* urine has a milky, turbid, and opaque appearance due to presence of fatty matter. Upon standing for some time, a tremulous coagulum occurs, succeeded by flakes, the fatty matter floating like cream on the surface. (Add ether to the urine, mix gently, the fatty matter is dissolved, and the urine assumes its natural color and transparency. If the ether be drawn off with a pipette and evaporated, it will yield a yellowish fat, solid or fluid). Oil globules are rarely to be seen with the microscope, since the fat is present in molecular form; with high powers, 450 diameters and upward, fatty particles may be seen.

Fatty globules present in renal casts will be hereafter noticed. Fat or oil globules themselves are easily identified by the microscope, if not dissolved by other constituents of the urine; they present the form of smooth, roundish, flattened discs, or, if compressed, are polyhedral in form; they strongly refract light, which gives them a sharp, dark outline with transmitted light, and with reflected light, a whitish center, and a shining silvery outline.

To practice identification of oil globules in the urine, agitate strongly some fresh urine with a little milk, and then examine a drop with the microscope.

When we see fat drops floating on the surface of a specimen of urine, it is well, before making a diagnosis, to be sure that unclean,oily or fatty urine glasses, chamber vessels, medicine glasses, etc., have not been used; if the urine has been drawn off with

a catheter freshly oiled, oil may be found in the urine.

Clinical Significance of Fat in the Urine.

Fat.—Rassman divides the affections in which fat occurs in the urine into three classes:

I. *Chyluria.*—parasitic and non-parasitic—where albumin, and, not infrequently, fibrin, are found.

II. *Fatty degeneration* at some point of the urinary apparatus—also where pus from an old abscess finds its way into the urinary passages.

III. *Constitutional affections* associated with marked cachexia or dependent on systemic intoxication, as:

(1.) Phthisis.
(2.) Long-continued suppuration.
(3.) Pyæmia.
(4.) Yellow fever.
(5.) Poisoning by phosphorus, by carbonic oxide gas (or after poisoning from external use of carbolic acid.—Weiss).
(6.) Chronic poisoning by turpentine.
(7.) Severe injuries to the bones.

In regard to *chyle* in the urine very little is known; its presence is not necessarily unfavorable, except when accompanied by coagulated fibrin and renal casts. It may occur during the course of epilepsy, erysipelas, diabetes, tuberculosis and other maladies. O. Bowen in the "*British Medical Journal*," reports a case where free oil appeared in the urine of a young person who was taking cod-liver oil, ceasing when the latter was discontinued.

Large amounts of oil in the urine may indicate not only an abscess opening into the urinary tract, but also may show that there is sloughing going on sufficient in extent to set free the oil of the fatty tissue; a case presenting the above conditions is reported by Dr. Cushing, of Boston.

Such cases as the above are rare and, in general,

unless the urine be chylous, no great amount of fat is usually found.

CLINICAL SUMMARY.

Deposits of Urates and Uric Acid. — These are found in

I. Normal urine in winter; if occasional, of no clinical significance.

II. Extensive cutaneous diseases as eczema, psoriasis.

III. Forms of dyspepsia associated with irregular secretion of gastric juice.

Absolute increase in acidity of the urine.

IV. Normal urine in summer; if occasional, of no clinical significance.

V. At the height of febrile disorders, especially rheumatism and in diarrhœa.

VI. Alternating with sugar in the urine.

Relative increase in acidity of the urine.

In these diseases uric acid is not necessarily in *excess*, but changes in the acidity of the urine cause it and the urates to be deposited. *Excess* of uric acid and urates is found in the urine in the following diseases:

I. Diseases of the liver, as acute yellow atrophy, cirrhosis and cancer; also in scurvy.

Decrease of other constituents.

II. Functional derangements of the liver, especially when too much animal food is ingested.

III. Antecedent conditions to the development of phthisis, cancer or sometimes diabetes: preceding the outbreak of such constitutional conditions as scrofula, syphilis, and of gout in its early attacks.

Increase of other constituents.

Although uric acid and the urates be in excess in the urine they may not be found as a deposit, if the reaction of the urine is but feebly acid.

If a deposit of uric acid occurs before the urine cools, or immediately after, the formation of gravel or stone is to be dreaded; if the deposit occurs three or four hours after the urine is passed, gravel and stone are not so much to be dreaded; if the deposit occurs twelve to twenty hours after the urine is voided, when acid fermentation has set in, it is perfectly normal.

Deposits of Oxalate of Lime.—These may be due to

I. Physiological causes: *a.* derived directly from the food by the ingestion of substances containing oxalate of lime, as rhubarb, etc. *b.* Derived indirectly from the food by incomplete oxidation of the sugars, starches, and fats. Regulation of diet, change of air, etc., improve the condition.

II. Pathological causes: *a.* many disorders of the liver, heart and lungs—high-colored urine. *b.* Spermatorrhœa. *c.* Cases of dyspepsia to which the term "oxaluria" is given owing to the persistency of the oxalate deposit—light colored urine.

A constant, large deposit of oxalate of lime renders the formation of oxalate of lime (mulberry) calculus possible, especially if the crystals are of the dumb-bell variety.

Deposits of Phosphates.—These are due to an alkaline or neutral reaction of the urine and may be found:

I. Normally after a meal or after partaking of fruit, carbonates, citrates, or acetates.

II. Abnormally in various conditions: *a.* if the deposit be seen daily and be *amorphous*, i. e., contain no crystals, nothing of great moment is indicated except *nervous exhaustion*, as from severe

study or loss of sleep. *b.* If the deposit be *crystalline* and no diet rich in lime at the same time be taken, diseases of the *spinal-cord*, and *chronic vesical* affections are indicated; especially is this the case if the crystals be those of *ammonio-magnesium phosphate*—triple phosphate. If triple phosphate be persistently deposited in the comparatively fresh urine, there is reason to fear formation of calculus. Crystals of triple phosphate occurring in stale urine, when not found in fresh, are of no clinical significance.

Fat in the Urine.—Found in (1.) chyluria—urine containing chyle, (2.) fatty degeneration of some part of the urinary apparatus, (3.) constitutional affections associated with marked cachexia as phthisis, pyæmia, etc.

RARE CONSTITUENTS OF THE SEDIMENT.

In case the constituents of an unorganized deposit can not be easily recognized consult the following table for the identification of various substances some of which have not yet been mentioned.

MICRO-CHEMICAL SUMMARY.

(UNORGANIZED DEPOSITS.)

Chemical.	*a.* If a deposit is partly or wholly soluble in *acetic acid* look in a fresh amount of the deposit, to which nothing has been added, for triple phosphate and calcium phosphate. *b.* If a deposit is slowly soluble in *acetic acid*, giving rise to colorless tablets of uric acid, look for urates. *c.* If a deposit is insoluble in acetic acid, look for uric acid, hippuric acid, oxalate of lime, cystin, tyrosin (not too strong acid).

Microscopical

a. Triple phosphate: very large, transparent crystals, generally triangular prismatic in form. Found in *alkaline* urine only.

Calcium phosphate: generally *amorphous;* sometimes *crystalline* in pale, faintly *acid* urine with a tendency to alkaline fermentation. Crystalline calcium phosphate shows rods, either separate, in stellate groups, or in sheaf like bundles.

b. Urates are generally amorphous; the urate of soda may show "hedge-hog" crystals, or prismatic crystals arranged in star-like masses. Found in *acid and* in *neutral* urine.

c. Uric acid: large, red, yellow, or brown crystals, generally four-sided rhombs; found only in *acid* urine; best seen with a low power, 100 or 200 diameters.

Oxalate of lime: very small, octahedral (letter envelope) or dumb-bell crystals, best seen with a power of from 400 to 600 diameters.

Cystin: colorless, hexagonal tablets overlapping one another; sometimes square prisms. *Soluble in ammonia* and in this manner differentiated from uric acid which is not.

Tyrosin: (generally) deep-yellow, fine, short, acicular prisms in bundles, tufts, sheaf-like collections or spiculated balls. They are insoluble in not too strong acetic acid.

Hippuric acid: very rare deposit in *acid* urine, resembles triple phosphate

Microscopical — microscopically, but *insoluble* in acetic acid.

d. If a sediment contains none of the above or something else besides the above, look for: leucin, xanthin.

Leucin: (generally) yellowish spheres with sharp contours showing, with good light, radii and delicate concentric lines. *Insoluble in ether*; while fat (which leucin resembles microscopically) is *soluble.*

Xanthin: Whetstone crystals soluble on *heating.* (Uric acid not dissolved by heat). (Deems).

Cystin.—Cystin often occurs dissolved in the urine and may be precipitated by acetic acid. It also occurs as a sediment, mixed with urate of sodium; as a calculus its occurrence is rare. Not unfrequently, however, large concretions of almost chemically pure cystin are passed with urines containing cystin as a sediment. The little stones of yellow color and crystalline structure vary from the size of the head of a pin to that of a pea. Urine containing cystin is generally paler than healthy urine, frequently of an oily appearance, with occasionally a greenish tint and, usually, of low specific gravity. Its odor is said by the learned to be similar to that of sweet briar, but on decomposing it exhales sulphuretted hydrogen and some little ammonia. It forms white or pale fawn-colored amorphous deposits; under the microscope it is seen as colorless, transparent, six-sided plates or prisms. resembling the hexagonal plates of uric acid. They are, however, soluble in ammonia. To test a deposit for cystin, treat it with acetic acid and boil, by which means urates and phosphates will be dissolved; let the sediment, which is left undissolved, settle, decant the urine and add, to the sediment, nitric acid. Heat,

and the sediment, if cystin, dissolves leaving a reddish-brown mass on evaporation. If the microscope has shown us hexagonal plates or square prisms as well, we are able to identify cystin. Its clinical significance is unknown, save its liability to cause formation of calculus.

Leucin and Tyrosin.—These substances have been found in the urine in cases of acute yellow atrophy of the liver, phosphorus-poisoning, small-pox and various exanthemata; their presence, nevertheless, is not confined to the urine of these diseases, as they have been noticed in that of some nineteen others. In lighter cases leucin alone may be present, but the appearance of tyrosin is deemed significant of grave conditions. Under the microscope, leucin appears in the form of spheres which, if the illumination be sufficient, will exhibit radiating and concentric striæ; tyrosin shows very fine, long, delicate, silky, acicular prisms, arranged in bundles, tufts, or sheaf-like collections, often crossing each other, or forming spiculated balls. Tyrosin crystals are often colored yellow by presence of bile pigments.

ORGANIZED DEPOSITS.

Chemical Detection of Blood in the Urine.—Fill a bottle two-thirds full of spirit of turpentine, cork it loosely, and expose it to the light for several weeks; kept in this way it becomes well ozonized. When the test for blood is to be made, take equal parts of this ozonized spirit and of tincture of guaiac, say two Cubic centimetres, (about half a drachm) of each, mix and shake thoroughly in a test-tube, when an emulsion is formed. Next, let an equal quantity of the urine to be tested trickle down the side of the test-tube, held inclined, and let it stand a few moments. If blood be present in the urine, a bluish layer will

appear at the juncture of the urine and the emulsion, that is, about in the middle of the whole—(Almen's test). If blood is not present, a layer of a dirty yellow color is seen. If the tincture of guaiac be diluted with three or four times its bulk of alcohol, this test becomes a very delicate one, detecting even small traces of blood.

Use urine freshly passed, for both chemical and microscopical examinations, when blood is to be looked for.

Another test: precipitate the phosphates by a little alkali and heat, and they will be colored red if blood coloring matter is present.

Microscopical Appearances of Blood.—If the urine is acid and of average specific gravity, say 1020 to 1025, the blood corpuscles will be visible and shapely for several days, but when the urine is ammoniacal especially if it be of low specific gravity, they speedily disappear, in which case the blood coloring matter can, however, be tested for chemically.

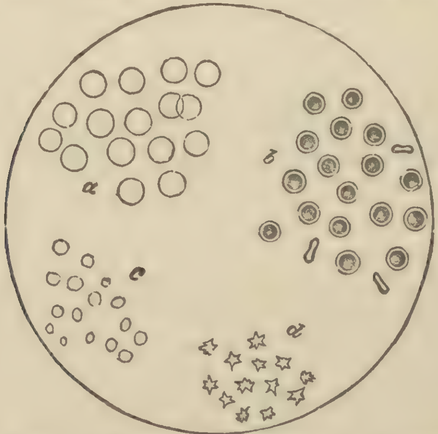

Fig. 11.—Blood Corpuscles in Urine.

a, slightly distended by imbibition; *b*, showing their bi-concave contour; *c*, shriveled; *d*. serrated.—Roberts.

To understand the appearance of blood in the urine, first study that of blood drawn from a blood-vessel, i. e., "normal" blood; the microscopical appearance of blood itself is that of globules or corpuscles without nuclei, smooth, flat, non-granular, yellow or reddish-brown and either detached or adhering in rouleaux. The discs being bi-concave a change in focussing will give a dark circumference and a light centre or the reverse; if the fluid containing them be set in motion the bi-concave form will be at once observed. Having learned the appearance of the blood drawn from a blood-vessel, next observe that occurring in urine (Fig. 11).

In acid urine, as has been observed before, blood-corpuscles retain their characteristic form for a long time; one point must be noticed and that is that blood-corpuscles in the urine are *separate* and sharply defined and do not run into rouleaux or rows like those of blood drawn from a blood-vessel, except in profuse hæmorrhages from the bladder.

They exhibit, however, small discs, showing a central shadow corresponding to the depression, and if standing on their edges they appear bi-concave. They appear reddish with a slight greenish tinge, i. e., paler than the normal.

So much then for the appearance of the blood corpuscles in acid urine of a specific gravity not far from 1028, that of blood serum itself. In case blood be sought for in such urine, the practitioner can easily compare the microscopical appearances with those of a drop of blood drawn from his hand by the prick of a needle. If the blood remains in such acid urine for several days its corpuscles may become somewhat notched or indented, thus differing from normal blood corpuscles.

The form of the corpuscles undergoes many changes coincident with those of the urine, and

when they are in watery urine (specific gravity 1010 or less) the description given above will not apply.

In such urine of low specific gravity, the corpuscles imbibe enough water by endosmosis as to swell visibly, to become bi-convex instead of bi-concave, and then even spherical, losing their color from the exosmosis of coloring matter to such an extent that the "busy practitioner" will lose considerable time in trying to identify them unless he have a very superior or powerful lens.

Urine of low specific gravity containing blood is likely to become alkaline and decompose very soon, and then the blood-corpuscles are no longer recognizable. In order to identify blood-corpuscles with ease, the urine should be acid in reaction, of a specific gravity of between 1020 and 1028, and fresh.

To examine the urine microscopically for blood, let it stand for a time until any turbidity may have at least partially settled, then introduce a pipette well into the lower part of the glass and obtain a drop of urine which convey to a glass slide and drop there, place the same under the microscope, focus carefully to suit the eye. If a low power is used the red corpuscles may be confounded with spores of certain fungi; high power will show a nucleus in such spores but none in red blood-corpuscles.

If any uncertainty exist in the mind let the urine stand a few days when the spores aforesaid, if any, will germinate or bud, a habit to which red blood-corpuscles are not addicted.

It is sometimes difficult to distinguish red blood-corpuscles from the nuclei of renal epithelium except by their feeble refractive power and less coloration from magenta solution.

In general, especially if the urine be of acid reaction, average specific gravity, and recently passed, the

following description will lead the physician to recognize the red blood-corpuscles under the microscope:

"Circular discs or globules; non-nucleated; $\frac{1}{3500}$ inch in diameter; separate; edges smooth or dentated; transparent or of a faintly yellowish color; sometimes presenting a central depression, and if seen in profile, with a high power, bi-concave. If a drop of acetic acid be added they swell or shrink and present a 'raspberry' aspect." (Deems.)

If with Almen's test the blue coloration has been obtained with the microscope blood-corpuscles are identified, hemorrhage from some part of the urinary apparatus indicated. In applying Almen's test be sure that the lower strata of urine are examined. In urine of high specific gravity the blood-corpuscles frequently contract, shrivel, and become distorted, indented or "crenated" from exosmosis, so that their microscopical identification is not easy.

Clinical Significance of Blood in the Urine:

Two conditions must be distinguished: blood coloring matter *without* blood corpuscles, and *with* blood corpuscles.

Hæmoglobin in the Urine.—In certain diseases and after poisoning by certain substances, the coloring-matter of the blood may be found in the urine. Such a condition is termed *hæmoglobinuria*, and differs from "blood" in the urine in that no blood *corpuscles* can be detected with the microscope, the coloring matter alone being present. In such cases the urine may vary in color from red-brown to inky black.

Circumstances under which Hæmoglobin may be Found in the Urine:

I. Severe scurvy and purpura hæmorrhagica.

II. Typhus with dissolution of the blood; septic fever.

III. After scarlet fever, after transfusion of blood, and occasionally in hemophilia.

IV. Epidemically as a disease among the new-born.*

V. As a paroxysmal disease after exposure to cold or under certain malarial conditions (especially in young males).

VI. After poisoning by (1) phosphorus, (2) copper sulphate (Starr), (3) carbonic acid, hydrocyanic acid and arseniuretted hydrogen gases (inhalation of).

VII. In chronic lead-poisoning.

VIII. After injection of glycerine into the blood.

The temporary presence of this substance in the urine is not alarming, but when it occurs *permanently* the prognosis is doubtful.

Before the diagnosis of hæmoglobinuria is made the urine should be carefully examined for blood-corpuscles; if none be found some of the granular matter which may form the sediment should be dried on a glass slide, common salt rubbed into it, a hair laid across, a cover glass applied, and a drop of glacial acetic acid allowed to enter beneath the cover. If the slide be then warmed and subjected to examination with a power of 600 diameters, crystals of hæmin will be seen. Hæmin crystallizes in rhomboidal tubes. Further examination of some of the sediment, with the spectroscope, will bring out the two absorption bands between D and E, characteristic of oxyhæmoglobine.

Blood.—Blood itself may occur in the urine under the following conditions:

I. Kidney troubles, as (1) acute Bright's disease, (2) active or passive congestion, (3) cancer or fungous growths. (4) tubercle, (5) calculus in pelvis

* Seventy-eight per cent of babes born in Dresden during March and April, 1879, died of it.

of kidney or in ureter, (6) parasites, as *Bilharzia hœmatobia*, (7) pyelitis, (8) cancer of the pelvis and ureter, (9) traumatism.

II. Bladder and urethral affections.

III. External injury or violent exercise.

IV. Administration in large doses of certain drugs, as cantharis, potassium chlorate.

V. Supplementary to hæmorrhoids, or asthma.

VI. Menstruation, uterine or vaginal hæmorrhage.

VII. Intentionally mixed with the urine for the purposes of deception.

Urine containing blood may show, with the aid of the microscope, blood corpuscles; in such cases the term *hœmaturia* is used.

Urine containing blood will also contain *albumin*, since blood contains albumin; the "busy" etc., should not, therefore, jump at the conclusion that Bright's disease is present because he finds albumin in urine containing blood.

The following table may aid in the diagnosis of blood in urine:

From Kidneys.

BLOOD PASSED.	CHARACTER OF URINE.	PAIN, ETC.
Bloody urine with elongated clots from ureters, is generally albuminous, usually tube casts present, and symptoms of renal disease. Blood brown colored or like porter, and not	Urine smoky or blackish-brown, if acid; bright red if alkaline. Forms a brownish-red, pulverulent mass or deposit. Albumin is found as well as renal casts.	Pain when moulds of clotted blood form in the ureters and are discharged in the urine.

BLOOD PASSED.	CHARACTER OF URINE.	PAIN, ETC.
as profuse as when from bladder.		
Nephritic Colic.		
Frequently blood in urine from kidneys.	Constant desire to urinate. Sometimes blood clots in urine.	With pain in region of kidneys and along the course of the ureters.
Renal Cancer.		
Frequent and profuse bloody urine.	Pus and encephaloid matter present in the advanced stages.	Tumor found in the loins; and deep-seated pains.
From Bladder.		
Blood in small flaky clots, not mixed with urine, but passing with it.	Urine ammoniacal; with tenacious mucus and phosphatic deposits—in feeble persons. Urine alkaline.	Dull pain in region of bladder and at its neck; frequent desire to urinate. Sometimes retention from a coagulum in the urethra.
Abrasion or Ulceration of Bladder.		
Blood mixed with mucus or pus in the urine.	Frequent desire to urinate and urine putrid containing more or less muco-purulent matter.	Acute burning pain in pelvic cavity, with uneasiness.

BLOOD PASSED.	CHARACTER OF URINE.	PAIN, ETC.
Malignant Disease.		
Blood dark-colored, with putrid, offensive matters.	Urination often difficult, painful, and with frequent desire to void the urine.	More or less severe pain in vicinity of the disease.
From Urethra.		
Blood coming without urine, in drops or in a small stream. Sometimes small clots.	The first jet of urine only is bloody, the balance becoming clearer and natural.	Perhaps soreness at the part from which the blood issues.
Vesical Calculus.		
Blood in urine after exercising; or a drop or two with pain in the last expulsive effort at urination, and with pain at the time.	Urine passed often during the day; likely to be of a florid color, and the desire to urinate to be caused by any movements or exercise.	Pain in penis or perineum, felt after (and often before) urinating, especially when pain is increased by exercise. Usually pain at end of penis.
Probable Prostatic Hypertrophy.		
Blood intimately mixed with urine, dark colored and not much altered by circumstances.	Urine frequent especially during the night	More or less constant irritation at neck of bladder.

Chronic Cystitis or Chronic Inflammation of Neck of Bladder.

BLOOD PASSED.	CHARACTER OF URINE.	PAIN, ETC.
Urine contains blood-corpuscles, if any hæmorrhage be present. Mucus increased.	Urine frequent and in small amount during the day (frequently alkaline, fetid).	Pain low down in belly. Slight pain in expelling the last drop of urine.

Chronic Prostatitis.

Blood rarely if ever passed.	Urination unduly frequent; a small muco-purulent discharge from urethra; urine a little cloudy.	Diminished sexual desire. Pain at end of penis. Dull pains in perineum and vicinity.

Distended Mucous Membrane of Bladder.

	Urine difficult and incomplete; passes by drops involuntarily, but in full stream on catheterization.	Pain in penis or perineum felt before urinating.

Chronic Inflammation of Mucous Coat of Bladder.

Blood occasionally observed, especially when ulcerations or abscesses have formed.	Urine passed often during the day in small quantities at a time; alkaline. Mucus increased.	Dull pain in region of bladder. Heaviness in perineum; weakness in back.

It is wise to have the urine passed into two vessels—say an ounce or two into the first and the balance into the second vessel. Practice makes perfect.

In cold weather, urates are often deposited in the urine giving it a lurid appearance which may frighten the patient into a belief that blood is present: application of gentle heat will cause the fluid to clear if the urates are the constituents of the deposit.

In case considerable albumin and tube casts are found together with the blood, renal disease may be suspected (see Wood's Observations on Quantity). In bladder troubles blood may be found and a small amount of albumin corresponding to the blood, but no tube casts; likewise in urethral affections.

Detection of Pus in the Urine.—To detect pus in the urine by chemical means is not always easy, being in some cases impossible. Urine containing pus is milky and turbid when voided, sometimes acid but generally alkaline, is light colored, even whitish, and has the peculiarity of clearing on standing; for instance, if a bottle of turbid urine of light color is brought you and after letting it stand a few hours it is noticeably clear, examine the dense opaque yellowish-white sediment at the bottom of the bottle for pus.

To do this chemically, first heat a little of the mixed urine and deposit, and if it *does not clear*, carefully drain off all the urine possible without losing any of the deposit; which is conveniently done by holding a glass rod to the lip of the bottle and pouring the urine slowly so that it will trickle down the rod. Then to the deposit left in the bottle, add a small piece of solid potassium hydrate and stir some minutes with a glass rod. If the sediment consist of pus it will lose its white color, becoming greenish and glassy, at first thready, finally more compact, viscous and stringy, the latter quality being readily

noticed if any one attempt to pour it from one vessel to another. Mucus treated in the same manner becomes a thin liquid with flakes. If the amount of pus is small, the sediment will disappear and a thready, gluey liquid result. It is advisable to obtain the sediment as free from urine as possible, hence, after carefully decanting the urine which has stood for some time, pour the residue into a tall, cylindrical vessel and in turn allow this to settle, removing supernatant urine gently with a large pipette; in this way a maximum amount of sediment with a minimum amount of urine is obtained without filtering.

The above test is of value only when the urine is acid, or neutral in reaction and fresh; in strongly alkaline urine, pus, if occurring, is changed by the action of the ammonium carbonate formed, into the same gluey tenacious mass described above. When, therefore, a glairy, ropy deposit is found in urine of alkaline reaction, filter, and examine the filtered urine for albumin, being careful to notice the slightest turbidity. If albumin be found, even in very small amount, we may infer the presence of pus which, as is well-known, contains albumin.

Microscopical Appearances.—If the urine be acid or neutral, examine the sediment with a power of from 300 to 400 diameters, and a number of spherical, cellular bodies about one-third larger than red blood-corpuscles may be found (Fig. 12). They may be compared with laudable pus from any suppurating wound or abscess. If the urine is of high specific gravity, the pus-corpuscles will look smaller and more crumpled than when the urine is watery and of a low specific gravity, in which they appear expanded and clear. A drop of acetic acid placed under the cover glass will cause the nuclei to appear —the red blood-corpuscles have no nuclei—and

cause the granulations to disappear giving rise to residues of various forms and groupings; on further treatment with ammonia, the nuclei will disappear and the pus assume a viscous consistency which mucus never, under similar circumstances, acquires, Pus-corpuscles (Fig. 12) can not be distinguished,

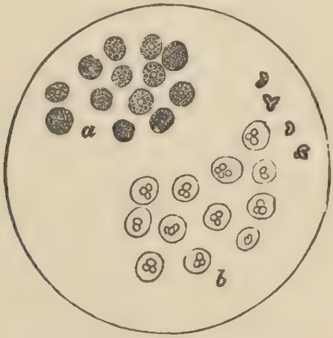

FIG. 12.—PUS CORPUSCLES.

a, without reagents; *b*, after the addition of acetic acid.—Roberts.

microscopically, from mucus corpuscles as regards form, but with high powers multiple nuclei may be observed. When the urine is alkaline the form of the pus-corpuscle is so changed as to be unrecognizable, although occasionally leucocytes may be found in the upper part of the deposit, together with crystals of triple phosphate, the organisms known as vibriones and filaments of fungi on their way to development.

The finding of albumin in the filtered urine, must be resorted to by chemical means for verification.

With the nitric acid test the albumin, in urine containing pus, will appear often as a mere haze, which however, is distinctly visible, if the author's test-apparatus be used.

Clinical Significance of Pus in the Urine.—According to Sir Henry Thompson, "pus may, and most commonly does, proceed from some local condition of the bladder." The abstract significance of pus in the urine is a suppurative process in the urinary tract (uropoietic system) or an abscess communicating with it.

The following table may be of value in determining the cause of pus in the urine:

PAIN, ETC.	OBSERVATIONS.
From Bladder.	
Symptoms of acute or chronic disease of the bladder, as strangury, etc.	Urine alkaline. Triple phosphates present in fresh urine. If urine be drawn off with catheter in severe cases, spindle-shaped cells, smaller than the vesical epithelial cells and nucleated, will be found with microscope.
From Ureters.	
Slight, colicky pains along the course of the ureter.	
From Urethra.	
That referable to gonorrhœa, etc.	Purulent fluid may be pressed out of the urethra *between* micturitions and "*shreds*" may be seen in the urine.
From Vagina.	
Symptoms referable to leucorrhœa.	Abundant pavement epithelium of vagina under microscope.

PAIN, ETC.	OBSERVATIONS.
From Kidney Pelvis.	
Lumbar pains. Absence of bladder or urethra signs.	Urine acid. Renal casts. Transitional epithelium seen with microscope.
From Kidney Parenchyma.	
Local symptoms very slight.	Long-continued presence of pus in urine.
From Abscesses Bursting into Urinary Passages.	
Symptoms referable to an abscess.	*Sudden* presence of large amount of pus in urine.

If pus be found in the urine for a few days and then disappear, we may conclude that the affection is superficial and not serious; if, on the other hand, pus be found steadily in the urine from day to day, some deep-seated and extensive alteration is indicated.

The urine of women often contains a little pus, and delicate tests may show presence of albumin due to purulent contamination.

Recognition of Mucus in a Deposit.—Mucus is often present in considerable amount in the urine without causing any turbidity. Urine containing an abundant amount of mucus filters very slowly, and if, after filtration, the filtering paper be dried, it will be found covered with a glistening "varnish" of mucus adhering to its sides.

a. Chemical Tests.—To ascertain whether the urine is charged with mucus when apparently clear, add to the freshly voided urine some acetic acid; if a considerable turbidity appear, which is cleared upon addition of hydrochloric acid, mucus in considerable amount is present.

When a plainly visible sediment is present in the urine causing one from its appearance to sus-

pect mucus, test the supernatant fluid for albumin, and to a little of the sediment add a few drops of Liquor Potassæ; if no albumin be found and the addition of the potassa to the sediment render it a thin, flaky liquid, it is mucus and not pus. The urine should be that freshly voided.

b. Microscopical Appearances.—Examine the deposit collected in the usual manner with a high power, 250 to 500 diameters. Mucus thus examined shows (1) epithelial cells, (2) mucus-corpuscles (3) various substances, as urates, uric acid, phosphates, fatty droplets, etc., etc.

It is desirable to identify the *mucus-corpuscles* in examining a deposit for mucus alone; these are often identical with pus-corpuscles. If a drop of acetic acid be added to the drop of sediment under examination, the nucleus of the mucus-corpuscles will be plainly seen, and pale, delicate, finely fibrillated, or punctated, bands or threads sometimes tortuous, and frequently anastomosed appear. This fibrillated substance is *mucin* precipitated from the mucus by the acid, It is difficult to distinguish mucus from pus microscopically, though high powers show (sometimes) a difference in nuclei; if mucus-corpuscles be found, test the urine for albumin and treat the deposit with Liquor Potassæ as before described.

We wish to call attention again to "muco-pus" which must not be mistaken for mucus; when, as in vesical catarrh, a glairy deposit is found adhering closely to the sides of the vessel, this is not mucus alone but a mixture of pus and mucus rendered glairy by the action of carbonate of ammonium. As has been observed before, this substance cannot be dealt with chemically nor microscopically to any advantage; the most we can do is to filter the urine and test for albumin which, if present in small quan-

tities indicates the presence of pus; also to observe whether triple phosphate crystals are present.

Significance of Mucus.—It will be remembered that a scarcely perceptible mucus "cloud", is normal in urine; when, however, this is distinctly visible and readily characterized, a pathological condition of the urinary passages is indicated.

Conditions under which Mucus is Present in Abnormal Quantity in the Urine:

I. Irritation of the mucous membrane of the urinary passages in general: vesical catarrh,—(mixed with pus).

II. Irritation of genital mucous membrane: (in women).

III. After gonorrhœa: (long mucous plugs).

IV. Fevers and acute diseases: pneumonia, pleuritis, typhoid fever, meningitis, intermittents, pulmonary and intestinal catarrhs, acute delirium, epilepsy.

Inasmuch as irritation of the urinary tract may develop into inflammation, it is of great importance that the practitioner be able to tell whether he have *mucus* present in a specimen of urine (irritation) or *pus* (inflammation); if he find large quantities of mucus he may be able by proper treatment to prevent the irritation of the mucous membrane of the urinary tract from developing into inflammation, and if pus be passed it is important not to mistake it for mucus.

Recognition of Epithelium in a Deposit.—The microscope must be used for this purpose. Epithelial cells found in the urine are of various forms best shown by Figs. 13 and 14. It is not always easy to tell just where epithelial cells have come from, but the following table may serve as an "approximate guide":

1. Round or oval epithelial cells a little swollen.	Very large with a single nucleus generally.	Urethra Blader (trigone).
	With two nuclei or one nucleus and nuclei form granulations.	Pelvis of kidney. Ureters—superficial layer.
	Much smaller.	Kidney — rarely in an isolated state. Bladder — near the neck.
2. Epithelial cells lamellar, very thin, polygonal.	A large nucleus, and often two nuclei and nucleiform granules.	Pelvis of the kidney and ureters—superficial layer.
	Very large lamellæ, but with very small nucleus.	Vagina and external genital parts. Urethra, near meatus.
3. Cylindrical, columnar, spindle-shaped, epithelial cells, with tail longer or shorter and more or less bent.		Bladder. Ureters. Pelvis of the kidney.

These cells appear large in comparison with blood or pus-corpuscles, when the same power is used to detect both. The central structure enclosed within the cell-substance is called the *nucleus*.

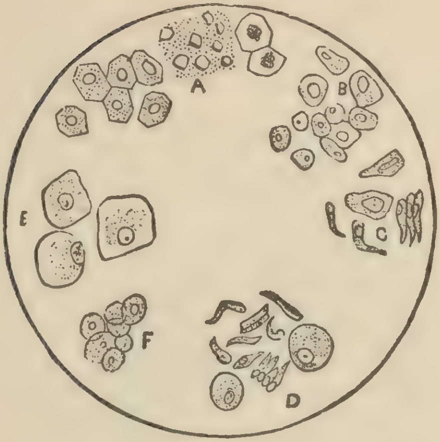

FIG. B.

A.—Glandular epithelium from the kidneys. B.—Tesselated-epithelium from the pelvis of the kidneys. C.—Epithelium with large and distinct nuclei, from the ureters. D.—Columnar epithelium, from the fundus of the bladder. E.—Large flattened cells, with a very distinct nucleus and nucleolus, from the trigone of the bladder. F.—Epithelium of the bladder. —(King.)

Clinical Significance of Epithelium:

A sediment occurring in the urine may contain epithelial cells from various portions of the urinary tract.

Diseases in which Epithelium is increased in the Urine:

I. Affections of the kidneys: serious if abundant and accompanied by albumin, blood, casts, etc.

II. Affections of the ureters: serious when as in I.

III. Leucorrhœa or specific inflammation of vagina.

IV. Catarrhal inflammation of lining membrane of the bladder.

V. Catarrhal or specific inflammation of urethra.

VI. Strumous diathesis: female children.

It must be carefully noted that an abundant, amorphous-looking, light, cloudy deposit, consisting of

epithelial cells from the vagina, is found in the urine of females when none of these diseases may be present; this deposit will be greatly increased in leucorrhœa.

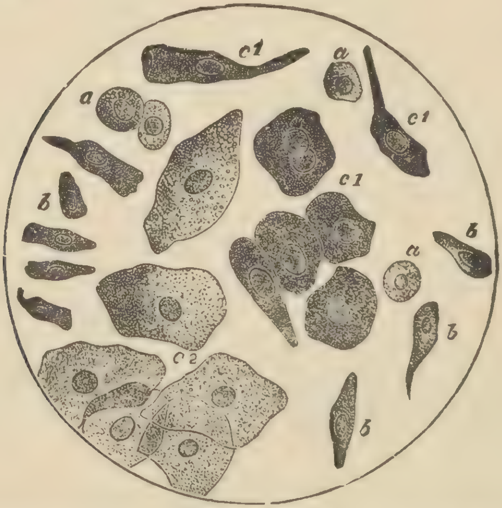

FIG. 14.

a, round epithelium from bladder; *b*, columnar epithelium from ureter and urethra; *c* 1, columnar and squamous epithelium from deeper layers of epithelium of bladder; *c* 2, squamous epithelium from superficial layers of epithelium of vagina.—Tyson.

In acid urine the epithelial cells are preserved for some length of time, but in alkaline urine they are gradually destroyed, becoming first swollen and transparent.

If, together with casts and albumin, the round cells are found, they have probably come from the uriniferous tubules, or if there are symptoms of impacted calculus from the pelvis of the kidney; otherwise from the urethra, Cowper's gland, or the prostate.

Detection of Casts.—Casts must be identified by the microscope. In order to collect them for examination proceed as follows:

(*a.*) *If the urine contains no deposit:*

1. Collect the urine for twenty-four hours.

2. Let it stand in a tall cylindrical glass from twelve to twenty-four hours according to the amount of albumin present, the more the longer.

3. Pour all the urine away except the four or five ounces at the bottom.

4. Let this four or five ounces settle again for two or three hours.

5. Take a drop of urine from the bottom with a pipette (or pour the urine into another vessel and examine one of the last drops) put it on a slide furnished with a *shallow* gum-dammar or cement *cell*, and examine with a power of from 100 to 250 diameters (low power in order to include a considerable quantity of urine.)

6. Having found tube-casts, study them with a higher power namely, 400 to 800 diameters.

7. If casts be not found on one slide, try several, and do not decide upon the case until several examinations have been made at intervals of several days.

(*b*) *When the urine contains a deposit:*

If the urine contain an abundance of casts they are much more readily found.

1. Let the urine settle a few hours.

2. Pour off the supernatant urine from the deposit which has settled and examine one of the last drops on a slide with a shallow cell as before in *a.*

Three or four varieties of casts may be seen:

I. *Epithelial*, (Fig 15^5) consisting of a mass of epithelial cells from tubules of kidney; they are generally wide, seldom narrow.

II. *Granular*, (Fig. 15^2) epithelial casts which have undergone molecular change are called "granular" owing to their dark, nearly black, coarsely granular aspect. Granular casts may be studded with minute oil globules, (Fig. 16) in which case they are

called "fatty or oil casts." Granular casts may have blood-corpuscles on them, in which case they are called "blood-casts"; in such a case they appear either as (1) perfect cylinders composed of delicate circles placed in apposition or (2) more often *fibrinous* cylinders irregularly studded with blood-corpuscles, some perfect, others shrunken and contorted or (3) blood-corpuscles, crushed or compressed into a cylindrical mould. In case the material of the granular casts be derived from broken-down blood-corpuscles, the casts will appear yellowish or yellowish-red. Gran-

FIG. 15.

1.—Massive fibrin cylinder. 2.—Granular cast. 3.—Hyaline casts. 4.—Waxy casts. 5.—Epithelial casts. 6.—Uric acid casts.—(Hofmann-Ultzmann.)

ular casts may be large or small, full of granular matter or only partially filled.

III. *Hyaline, Structureless or Waxy*, (Fig. 15³ and⁴) These are clear cylinders with well-defined margins delineated by a distinct line. They are sometimes rectilinear but more often curvilinear, having their extremities cut like glass; their surface is generally polished. Hyaline casts are formed of homogeneous, transparent material, and contain cracks and roughnesses due to blood globules and epithelial cells with here and there one or two glistening oil drops; their outlines are often so indistinct that, before they

FIG. 16.

can be detected, they must be artificially tinted with iodine or magenta, or the light from the mirror illuminating the field of view must be modified by shading with the hand, or by manipulating the mirror itself, the field of view being just outside the exact focus.

Hyaline means "transparent like glass," hence the name of these casts; when they are of more solid aspect they are termed "waxy" casts, from the resemblance to "molten" wax. Amyloid casts are hyaline casts which have undergone metamorphosis.

In advanced stages of Bright's disease the hyaline casts may be completely enclosed in a cortex of epithelial cells from renal tubules.

IV. *Mucous Casts* (Fig. 17). Not to be confounded with hyaline casts are those called mucous, which may frequently be found in normal urine; they have badly defined margins, are often twisted or varicose, but they are pale and smooth. Mucous casts are characterized by their great length, which is often enormous, in the course of which they divide and subdivide, diminishing in diameter as the division pro-

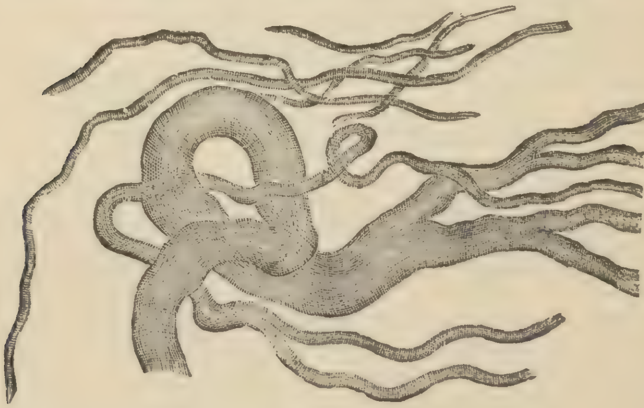

FIG. 17.

ceeds. They are often present with pus. According to Beale, also in urine of high specific gravity (1030 and upward) containing excess of urea and urates. As they are of no diagnostic value they must not be mistaken for hyaline casts.

Acetic acid renders them fibrillary and punctated but attacks hyaline casts very slightly.

Besides the four varieties of renal casts mentioned, there sometimes present in urine casts of the *seminal tubules* which may be distinguished microscopically, from the preceding by the presence in them of spermatozoids.

Fibres of wood, cotton, flax, wool, silk, and hair and other foreign bodies are often mistaken for casts; if some of the deposit be placed on a slide and a thin glass cover put over it, pressure on the cover with a needle will crush a renal cast but merely flatten any foreign body likely to be present. Hence it is desirable not to look for tube casts on an ordinary slide with a cover lest they be crushed; it is better to use, as previously specified, a slide with a cell in it.*

To decide whether an object seen with the microscope is a tube cast or not proceed as follows:

1. Rule out foreign bodies by the method of procedure given above.

2. Notice whether imbedded in or firmly adherent to the object are epithelial cells from uriniferous tubules, red blood-corpuscles or leucocytes. If no epithelial cells *at all*, examine several slides before concluding whether the objects are casts or not, since in the last stages of Bright's disease the uriniferous tubules have, in some cases, been stripped of their lining epithelium, hence no cells will be seen in or on the casts.

3. Observe the extremities of the objects under examination; casts usually have round or club-shaped extremities.

4. Casts are colored by carmine solutions; vegetable elements, fungi, etc., are not so colored.

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*It is, however, claimed that with high powers, hyaline casts cannot be so well identified in "cells" as on "slides."

Bear in mind the fact that a urinary deposit may, and generally does, contain a mixture of two or more varieties of casts and cells, hence ground your opinion upon the variety which is most and best represented.

Remember (*a*) that epithelial casts often contain besides epithelial cells, and red blood-corpuscles, white blood-corpuscles, pus-corpuscles, urates, uric acid, and especially oxalate of lime crystals.

Remember (*b*) that in icteric complications all casts may be colored by bile or interspersed with urates or crystals (cleared by acetic acid).

Clinical Significance of Tube Casts:

A urinary sediment may contain tube casts; these are cylinders or moulds formed in the uriniferous tubules, and consisting of some transparent material which is formed in or poured out into the canal and there made firm, entangling in its meshes whatever may be in the tube at the time of its effusion.

Their presence in the urine is significant of congestion or inflammation of the kidney; this may be (1) temporary or (2) permanent. Constant presence of tube casts in the urine may indicate serious trouble, if albumin, blood, etc., occur, and the quantity of urine is abnormal.

Diseases in which Tube Casts Appear in the Urine:

I. All cases of renal congestion and in acute or chronic Bright's disease.

II. Acute diseases (temporarily): bronchitis, pneumonia, convalescence from scarlet fever.

III. After heavy doses of various drugs.

IV. Purulent infections (some forms); icterus after attempt at asphyxia with charcoal.

Classification of Casts.—Description.—Voluminous, of greater or less length (rarely exceeding $\frac{1}{50}$th of an inch); variable aspect; pale or hyaline,

granular or covered with epithelium; sometimes distinctly, sometimes indistinctly outlined; generally round or club-shaped extremities:

(*a.*) Very pale or transparent, amorphous cylinders.	With badly defined margins, often twisted or varicose, branching and sub-dividing.	Uncolored by carmine.	*Mucous casts.*
	With clear, well-defined margins, sometimes intersected by fractures.	Colored by carmine.	Hyaline or waxy casts.
(*b*) More or less dark, epithelial, or granular cylinders (200 to 400 diameters).	No line of contour; epithelial cells united into a cylinder. Never very narrow.		Epithelial or granular casts.
	A more or less distinct line of contour; fundamental substance, finely granular, studded with blood corpuscles.		Fibrinous or blood casts.

Any of the above may undergo fatty degeneration.

Bright's Diseases and Tube Casts.—In acute desquamative nephritis we may expect to find epithelial casts, as well as both large and small hyaline casts, blood and oil casts; when the acute desquamative nephritis has passed into the chronic state, albumin but not necessarily casts, may be present in the urine for several years. As the chronic disease progresses the urine loses its normal color and grows more or less colorless, the deposit more dense and

copious, containing large granular and hyaline casts indicative of granular contraction of cortical portion of the kidney,

A few oily casts and cells, together with other casts, have no special unfavorable significance, but if albumin be found steadily for weeks and months, and oil casts preponderate in the deposit, there is reason to fear *fatty degeneration.* After scarlet fever, in some cases, instead of the desquamative tubular nephritis which often results, we may find what is called *glomerulo-nephritis*, indicated by presence in the deposit of *white cell casts.*

The *small*, *red*, *granular* kidney is indicated often by copious amount of urine of low specific gravity, not always much albumin, granular casts and scattered epithelial debris, and late in the disease often large hyaline casts.

Lardaceous degeneration is not always easy to diagnose from the urine which, however, may be copious, clear and containing no sediment, but in most cases a light cloud can be seen containing small, hyaline, and finely granular casts with, occasionally, oil casts and cells. It is well to bear in mind that Bright's disease should not be diagnosed solely from observation of certain conditions in the urine; it is not the province of this work, however, to dwell upon the dropsy, condition of the eye, headache, giddiness, twitching or cramp in certain muscles, dry harsh skin, condition of heart, etc., which may be found in the course of the malady.

Recognition of Spermatozoa.—Spermatozoa found in urine have no movement unless a very considerable amount of pus be present: they resist elements of destruction very successfully and may be found intact in putrid urine, of several months' age. Ammonia rapidly destroys their form.

When present in the urine together with the semi-

nal fluid, a glairy, white deposit is found, but the spermatozoa themselves are not visible to the naked eye.

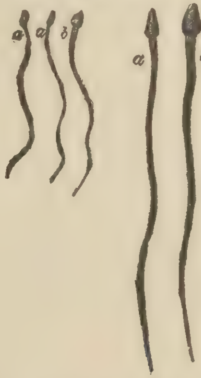

FIG. 18.—HUMAN SPERMATOZOA.

1.—350; 2.—800 diameters. *a*, viewed from the side; *b*, from the front.

Let the deposit settle as usual, dip in the pipette and place a drop on the slide; if there are many ingredients of the deposit interfering with a recognition of the spermatozoa, add a little acetic acid if the deposit is phosphatic, or a little 10 per cent. potassa solution if of urates. Use a power of 250 diameters first, in case only a few should happen to be present, afterward 400 to 600 diameters, to show them well. They have an oval or pear shaped head or body and a long, extremely delicate, finely tapering tail. They are very refractive and of a peculiar bluish tint and, as it were, of a fatty lustre, hence most easily detected when viewed just outside of or beyond the exact focus.

Clinical Significance of Spermatozoa.—Spermatozoids may be frequently found in the urine of males in a state of health. Constant presence of them together with other more important symptoms may indicate masturbation.

Conditions under which Spermatozoa are found in the Urine.

I. After coition or nocturnal emissions.

II. During typhus.

III. In so-called "spermatorrhœa."

Method of Collection.—Rouvier's method of collecting spermatozoa is as follows: collect the urine for twenty-four hours, let it settle for two hours, decant the urine from the sediment, collect the latter in a test-tube and shake it up with ether. On standing, the ether will come to the top, when, on draining it off with a pipette and adding a few drops of distilled water, the microscope will show the spermatozoa.

Fungi.—Four varieties are of interest (Fig. 20): (1) sarcinæ; (2) bacteria; (3) penicilium glaucum; (4) torula cerevisiæ. The only fungi found in freshly-voided urine are those called *sarcinæ*; these are (Fig. 20³) square bodies subdivided into secondary squares which number 2, 4, 8, etc., resembling those found in the vomited matter of persons suffering from stenosis of the pylorus although smaller.

After urine has been voided some little time, other organisms may be found in it. *Penicilium glaucum* (Fig. 20²) is the common blue mould found in vinegar and all albuminous fluids; when urine contains albumin, a plentiful amount of this fungus may be found a few hours after it has been passed. Its *sporules* may be mistaken for blood-corpuscles, but, if set aside for a few days, they bud and the *thallus* is produced from which eventually spring the ascending stems of the *aerial fructification*. These fungi flourish in acid urine, but perish in alkaline. It will be remembered that fungi are not colored by carmine solutions, while casts, epithelia, etc., are. *Torula cerevisiæ* (Fig. 20¹) is the yeast or sugar fungus, but may be found in urine which contains no

sugar; nevertheless, in diabetic urine it begins to form in a few hours, and is often developed in twenty to thirty-six hours after the urine has been voided, beginning as sporules and developing into thallus and aerial fructifications. It is difficult to distinguish torula cerevisiæ from penicilium glaucum until the aerial fructification has been reached, in which the torula has a globular head while the penicilium presents a tuft of branches.

When urine for any reason is decomposed, very delicate bodies called *bacteria* may be seen, with a power of 200 diameters, exhibiting active motion, rotary or vibratory. A power of 500 diameters is required to show them well.

FIG. 19.—BACTERIA AND VIBRIONES.

From urine three days old; 400 diameters.—(Beale.)

Vibriones or vibrios (Fig. 19) are filiform bodies, more or less distinctly jointed from imperfect division, and having an undulating movement like that of a serpent.

Cancer Elements.—In cases of cancer of any part of the urinary apparatus as the bladder, two different forms of cancer element are sometimes observed: (*a*) isolated cancer-cells; (*b*) pieces of cancer-tissue.

Cancer-cells are of great variety of form and often quite oddly formed; they may resemble epithelial cell of the urinary passages. It is only from an abundant appearance of peculiar and many-formed

cells that a malignant growth can be recognized with any certainty.

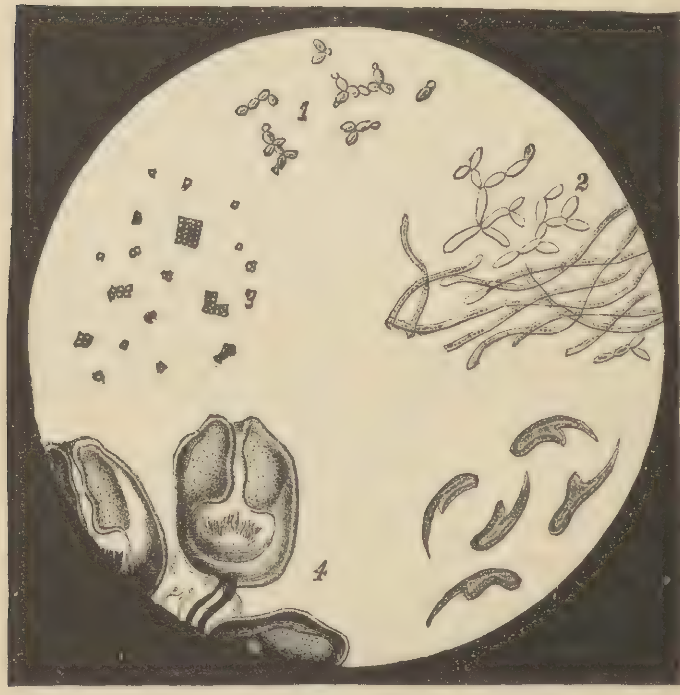

Fig. 20.

1. Yeast fungi.—2. Penicilium glaucum.—3. Sarcina.—4. Cyst of the echinococcus with detached hooks.—Hofmann and Ultzmann.

Fragments of villous cancer may be seen in the sediment of urine.

If the tissue is well preserved, which it seldom is, under a power of 300 diameters a tree-like formation similar to fringe may be seen; usually, however, only sloughed off and much altered pieces of tissue appear in the sediment and the identification of these is very difficult.

If crystals of hæmatoidin (small rhomboid prisms insoluble in water, alcohol, ether, acetic acid, glycerin, dilute mineral acids and dilute alkalies, of a red or yellow color) be found imbedded in tissue in urinary sediment, the diagnosis of old hæmorrhagic and necrotic tissue, as found in villous tumors, may be made. Sometimes on treating necrotic, cancerous tissue with glycerin, crystals of hæmatoidin may be seen, either as rhomboids or small, yellow, grassy tufts.

Sometimes with a low power, 120 diameters, thicker and darker colored, tuft-shaped, branching forms may be observed in necrotic flakes.

If the urine is strongly alkaline, the villous tissue may be so changed and incrusted with phosphates that a diagnosis can scarcely be made.

FUNGI:

Sarcinæ appear to be formed in the urine before it is voided; they are found in both acid and alkaline urine and are generally associated with some disorder of the urinary organs.

Bacteria in the urine show that putrefactive changes have set in; the urine containing them soon loses its transparency and deposits a sediment of a cloudy appearance; its odor becomes offensive and the reaction soon ammoniacal. The urine of women often contains bacteria and shows a generally diffused turbidity.

Mould Fungus (Penicilium glaucum) is often found in acid urine and grows luxuriantly in albuminous urine.

Yeast or Sugar Fungus (Torula cerevisiæ) grows luxuriantly in diabetic urine exposed to a moderate temperature. It has been found in urine in which no sugar could be demonstrated.

CLINICAL SUMMARY.

(ORGANIZED DEPOSITS.)

Blood in the urine is significant of hæmorrhage somewhere in the urinary tract; it is found (1) in the various forms of Bright's disease, (2) in bladder or urethral affections, (3) after the administration of certain drugs. It must be remembered that the urine of menstruating women or those suffering from uterine or vaginal hæmorrhage may contain blood. Urine containing blood will answer the tests for albumin. To tell whether albumin found in urine when blood is present be "*kidney* albumin" or simply that due to the presence of blood look for evidences of kidney disease; examine the urine for tube-casts, etc.

Blood coloring matter is found in the urine in certain diseases which accompany dyscrasia and blood degeneration, as in scurvy, putrid typhus, etc. *Temporary* presence of blood coloring matter in the urine is of no serious import; when *permanently* found the prognosis is doubtful. Urine containing blood coloring matter has a color varying from red-brown to inky-black, and when boiled yields a brown-red coagulum.

Pus in the urine is significant of suppuration somewhere in or near the urinary tract; it may and most commonly does proceed from some local condition of the bladder. In women, pus in the urine may be due to vaginal causes in which case an abundance of epithelium of the pavement variety may be seen with the microscope. An abscess bursting into the urinary passages will make itself known by the sudden presence of a large amount of pus in the

urine. Urine containing pus will be found to contain albumin due to the pus; to differentiate from kidney albumin look for evidences of kidney disease as in case of Blood.

Mucus in abnormal quantity is indicative of irritation of the mucous membrane of the urinary passages. This irritation may develop into inflammation, when it will occur mixed with pus. The amount of mucus is increased in fevers and acute diseases; after gonorrhœa long mucous "plugs" may be found in the urine. Irritation of the genital mucous membrane in women may cause considerable mucus to be found in the urine.

Epithelium in the urine may be found in increased quantity in the various diseases of the uro-poetic system. In female children of a strumous diathesis it is plentiful in the urine. An amorphous-looking, light, cloudy deposit, abundant in quantity is frequently found in the urine of females, consisting of epithelial cells from the vagina; this deposit will be greatly increased in leucorrhœa.

Tube-casts are found in the urine in all cases of renal congestion, and in acute or chronic Bright's disease. If tube-casts are found in the urine for several weeks, it is well to examine the urine carefully for other constituents.

I. A plentiful amount of albumin with numerous casts, renal epithelia, or fatty cells, strongly indicates Bright's disease; if the casts are granular or hyaline, a grave disease of the substance of the kidney likely to assume a chronic course is indicated; if hyaline casts are present accompanied by the oily variety of granular casts the prognosis is also unfavorable.

II. Pus and casts together indicate severe inflammatory process (pyorrhœa) either in the parenchyma of the kidney or in the calices and pelves.

III. Blood and casts indicate, probably, a disease of the vessels of the kidney, such as fatty or amyloid degeneration of the renal arteries.

IV. If the casts contain daily a considerable amount of fat, we may surmise fatty degeneration of the kidneys.

V. Casts of very small diameter may indicate narrowing of the renal tubules; casts of very large diameter may indicate dilatation of the renal tubules; casts of very unequal diameter, with bulgings and contractions, may indicate a varicose or distended condition of the renal tubules.

Spermatozoa may frequently be found in the urine of males in a state of health. Constant presence of them together with other symptoms may indicate that masturbation is practiced. They are found in the urine voided after coition or nocturnal emissions, during typhus, and in the so-called "spermatorrhœa."

Fungi are usually found in urine containing albumin or sugar, or that which has begun to decompose. Sarcinæ may be found in freshly voided urine in cases of vesical catarrh, dysuria, renal pains, dyspepsia, hypochondria. Bacteria indicate that putrefactive changes in the urine have set in. Vibriones or vibrios may be found in the pale urine of cachectic and debilitated persons and those extremely prostrated by phthisis, mesenteric and syphilitic diseases.

MICRO-CHEMICAL SUMMARY.

(Organized Deposits.)

a. If the urine is turbid when first voided, examine the sediment for *organized* bodies.

b. If with a power of from 400 to 600 diameters, small, *round* or *oval* bodies be seen, look for: red

blood corpuscles, white blood corpuscles (leucocytes, pus corpuscles), fungus spores, spermatozoa.

Differentiation.—To a portion of the sediment add a drop of carmine solution; if the round or oval bodies become *colored*, to another portion of the deposit to which nothing has been added, add *acetic acid*. (This may be done by introducing a drop of the acid beneath the glass cover—see Introduction.) If the bodies become pale and two or three *nuclei* appear, *leucocytes* are present in the deposit.

If the round or oval bodies do *not* become colored by the carmine, to a fresh amount add dilute acetic acid; if the bodies swell, or shrink, presenting a "raspberry" appearance *without nuclei*, especially if transparent or of a faintly yellowish color, *red blood corpuscles* are present. (Verify by study of their appearance, characteristics, etc.)

If neither carmine nor acetic acid causes any change in appearance, look for spermatozoa and fungi; spermatozoa have the general appearance of minute tad-poles; if the latter be not found, set the slide aside for a few days and if on re-examination the bodies have germinated, *fungi* are present.

c. If with the same power as in (*b*) *larger* bodies are seen, of variable form, such as round, oval, lamellar, cylindrical, fusiform, caudate or irregular, showing nuclei and granular contents, *epithelium* is present. Add *acetic acid* and the bodies become pale and the nuclei are distinctly exhibited. To a fresh portion of the sediment add carmine and they become colored.

d. If cylindrical bodies be seen, *tube-casts* may be present. (See Tube Casts.)

e. If with a power of 500 diameters and upwards, *very small*, transparent bodies be seen, generally exhibiting active vibratory movements, *bacteria* may be present Acetic acid arrests their motion.

f. If the bodies present a *filamentous* or *fibrillary* appearance, look for thallus of fungi, fibrin, mucus.

Differentiation.—To a portion of the sediment add *acetic acid*; if no change, *thallus* may be present. If on addition of acetic acid a swollen, transparent, amorphous mass appear, *fibrin* may be present; if the appearance is more distinct and punctated or striated, *mucus* may be present.

CHAPTER IV.

NORMAL CONSTITUENTS.

Those normal constituents of urine which are of special importance in diagnosis are urea, sodium chloride, phosphates, earthy and alkaline, sulphates, and urates.

After having ascertained the physical chracteristics of urine, and examined it for abnormal constituents it is well after identifying the contents of any sediment to filter the urine and test it for its normal constituents.

Detection of Urea.—No *simple* qualitative test for urea is known, but all operations tend to show the *amount* of urea present in the urine. The following method has been recommended as sufficiently accurate for practical purposes in determining the amount of urea present in a given specimen of urine:

Upon a glass slide place a drop or two of the urine at ordinary temperature and add to it an equal quantity of concentrated nitric acid; if crystals (urea nitrate) form at once or within five minutes, there is an *excess* of urea. If the crystals form in from five to ten minutes, the amount of urea is *normal.* If the crystals do not form in ten minutes, there is a *deficiency* of urea.

In cases where it is desirable to know the amount of urea excreted in a day, collect the urine for twenty-four hours and estimate the urea by the method of Fowler.

Fowler's Method for the Estimation of Urea.—Obtain some standard solution of chlorinated soda (Squibb) and proceed as follows:

Take the specific gravity of the twenty-four hours' urine and of the chlorinated soda solution, separately. Add the specific gravity of the urine to that of the soda solution after multiplying the latter by 7; for example suppose the specific gravity of the urine to be 1015 and that of the soda solution to be 1048; $1048 \times 7 = 7336$; add 7336 to 1015 and we have 8351. Next divide the same by 8; in this case $8351 \div 8 = 1044$, nearly. Then mix 15 parts of the urine, say 15 Cubic centimetres, with 105 parts of the soda solution, say 105 Cubic centimetres, shake well and let stand for at least two hours, after which take the specific gravity and subtract it from the result of the division by 8. The difference multiplied by 3.55 will give the number of grains of urea to each fluid ounce of urine under examination (the difference multiplied by 7.791 will give the number of milligrams of urea to the Cubic centimetres of urine). Further multiplication of the total number of ounces of urine passed during the twenty-four hours will give the total amount of urea in grains. Thus, suppose in the case mentioned above, after mixing, the specific gravity was found to be 1041; subtract this 1041 from 1044 (the result of the division by 8) and the difference is 3. Multiply 3 by 3.55 and we find 10.65 grains of urea to the ounce. Suppose 40 ounces of urine were passed during the twenty-four hours—then 10.65 multiplied by 40= 426 grains of urea voided in twenty-four hours.

It is evident that with this method we must be able to fix the point at which the urinometer floats in the several liquids with nicety. When these liquids are perfectly transparent there is no difficulty, the proper way being to read from the under surface of the fluid, bringing the eye on a level with that surface. When the urine from any cause is opaque, either filter it carefully or resort to the

following simple device recommended by Fowler; take a piece of soft pine and shape it into a circular disk somewhat smaller than the calibre of the smallest cylinder to be used. Make it exceedingly thin and uniform, and perforate it in the centre with a round hole which will freely accommodate the stem of the urinometer. Having put the stem of the instrument through this opening and immersed it in the fluid, the bit of wood will float on the surface, and the specific gravity can be readily taken by noting the point at which the float comes in contact with the stem. The weight of the wood will cause a slight increase in the specific gravity, but when used in every case the error will be the same and correct itself.

[An instrument, by which the percentage of urea estimated can be read directly from the apparatus used, has been devised by Parke, Davis & Co. The same solution—Liquor Sodæ Chloratæ—is used, and the manual operations are not difficult. I have written a full description of the process employed in Part II. of the "The Manual of Simple Chemical Tests." Dr. Squibb has also devised a ureometer which can be conveniently used by physicians desirous of estimating urea].

Estimation of Urea.—Hypobromite Process.—One of the best methods of estimating urea by the use of hypobromite, is that of Yvon, which is a modification of the Knop-Hueffner method; with the necessary apparatus the analysis can be made in five or six minutes at the patient's bedside. The apparatus consists of a long, wide, bell-mouthed beaker and a glass tube called an ureometer, 40 centimetres long and 1 centimetre in diameter. The ureometer is divided into two compartments by a glass stop-cock placed toward its upper quarter, which allows a communication between the two compart-

ments to be established or suppressed at will. Commencing at this stop-cock, the tube is graduated, above and below it, into Cubic centimetres and tenths of the same. The lower part of the tube is the longest, from its extremity to the stop-cock, and is designed to be placed into a mercury jar, as hereafter described. The *standard* solution employed consists of solution of caustic soda, (36°). 30 grammes, dissolved in distilled water, 125 grammes, to which add, when cold, bromine, 5 grammes, and agitate strongly. Allow it to rest for some time, and, after decantation, a fine yellow, clear, transparent fluid remains which has to be frequently renewed, as it loses considerable of its strength in a very short time. By keeping the solution of caustic soda, separately, the mixture may be made in small quantity, whenever required, by adding to any given amount of the soda solution the proper proportion of bromine. [As a *test liquor* of this standard solution, 1 gramme of pulverized urea, well dried by a prolonged sojourn under a bell glass with sulphuric acid, is dissolved in 500 C. C. of distilled water so as to have 5 Cubic centimetres of the solution equal to 1 centigramme of urea. After the action of the standard solution of hypobromite of soda, upon this solution of urea, 37 divisions of the tube will correspond to one centigramme of urea]. Ten Cubic centimetres of urine freed from albumin are diluted with distilled water to make a volume of 50 Cubic centimetres, and of this diluted urine from 1 to 5 Cubic centimetres are operated upon, according to its richness in urea. Polyuric urine requires no dilution. We must always endeavor to have no more than forty divisions of gas, in order not to increase too greatly the volume of the standard solution to be employed, and the dimensions of the

column of liquid. The method of proceeding is as follows: open the stop-cock and plunge the inferior extremity of the tube into the jar filled with pure mercury, until this has risen to a level with the lower part of the superior compartment; then close the stop-cock, raise the tube (but not entirely out of the mercury,) the inferior compartment of which is filled with the mercury, and maintain it in this position by means of a strap or collar, which forms part of the complete apparatus. Into the upper apartment place from 1 to 5 Cubic centimetres of the diluted urine, open the the stop-cock, and carefully make the fluid flow into the inferior compartment, closing the stop-cock before any air can pass along with it. Wash the receptacle at the superior part of the tube with several drops of distilled water, and carefully pass this into the lower apartment, by means of the stop-cock, as in the previous instance. This done, place in the upper receptacle five or six Cubic centimetres of the standard solution, and, as in the first instance, make it pass into the lower apartment raising the tube a little should this be necessary. Agitate by an up-and-down motion, but without removing the tube entirely out of the mercury, having the stop-cock closed, of course. Decomposition occurs immediately, the urea is separated into water, nitrogen, and carbonic acid gas; the last being absorbed by the excess of alkali, nitrogen alone remains in the tube. To render the mixture more exact, raise the tube, close tne lower orifice, while this is under the mercury, with a finger, and shake it; then carefully replace it in the mercury. The liquid soon becomes limpid when all the gas has collected together, and the amount of gas may be read off on the graduated divisions at the level of the fluid remaining in the lower compartment. The measurement of the gas is made in a beaker filled

with water, being careful properly to place the surface of the liquid in the tube on a level with that of the fluid in the beaker. For instance, 5 Cubic centimetres of the diluted urine have been operated upon, and we find 22 divisions of gas produced, and as 5 Cubic centimetres of the standard solution represents 1 centigramme of urea, we have $\frac{22}{37}$ of a centigramme of urea. But the urine has been diluted to five times its volume with water, from which we can readily conclude that 1 Cubic centimetre of the original undiluted urine contains $\frac{22}{37}$ of a centigramme of urea. If 800 Cubic centimetres of the urine are passed in twenty-four hours we have $800 \times 22 \div 37 =$ 4.754 grammes of urea in 800 Cubic centimetres of urine or 5.945 grammes of urea in 1000 Cubic centimetres of urine.

Clinical Significance of Urea.

Urea is a substance composed of one part carbon, four parts hydrogen, two parts nitrogen, and one part oxygen—by weight; its most important constituent from a clinical point of view is *nitrogen*, since five-sixths of all the nitrogen absorbed in the food passes out of the body as a component part of this chief constituent of normal urine. Pure urea is white, semi-transparent, and crystalline (four-sided or circular crystals), odorless, of a bitter, cooling taste, somewhat like that of nitre. Urea is very soluble in water and is therefore never visible in the urine; to obtain it in the pure state described above, various chemical processes are required.

The amount of urea present in urine is indicative to a certain extent, of the wear and tear of the system—taking into careful consideration circumstances of diet, habit, etc. The normal amount of urea passed in twenty-four hours is from 25 to 40 grammes (385 to 600 grains).

According to Brouardel, the quantity of urea

depends upon the integrity of the hepatic cells and the greater or less activity of the hepatic circulation.

Tables of Harley:

Normal urine of twenty-four hours:

Boy, 18 months,	8–12	grammes,	124.0–186.0	grains.
Girl, "	6– 9	"	93.0–139.5	"
Man, 27 years,	25–35	"	387.5–542.5	"
Woman "	20–30	"	310.0–465.0	"

Proportion of urea according to weight:

Boy,	0.4	gramme,	- - -	6.2	grains	to the	pound.
Girl,	0.35	"	- - -	5.4	"	"	"
Man,	0.25	"	- - -	3.8	"	"	"
Woman,	0.20	"	- - -	3.1	"	"	"

These tables show that children, relatively, excrete more urea than adults, and that men excrete absolutely and relatively, more than women. The "average man" then excretes about 3.8 grains of urea to the pound of weight—the average woman, 3.1.

Purely animal diet will increase the daily amount of urea to from sixty to ninety grammes; purely non-nitrogenous diet will reduce it to less than fifteen. Hence in diseases where there is excess of urea animal diet is strongly contra-indicated.

Diet which may increase the amount of Urea:

I. Animal food, especially lean meat; animal soups.

II. White of egg, milk, jellies, coffee without sugar.

Diet which may decrease the amount of Urea:

I. Amylaceous foods: tapioca, arrow root, sago.

II. Sugar.

III. Oleaginous foods: cream, cod-liver oil, etc.

The latter diet is indicated when there is excess of urea in the urine; if the patient crave meat give him meat fat.

Vegetables may be allowed when it is desired to

decrease the amount of urea; a purely vegetable diet will diminish it one-third.

A careful distinction must be drawn between a diminished *excretion* of urea and a diminished *formation* of it; in some diseases urea, although formed in the body is held back and does not appear in normal amount in the urine, in others it is scantily formed in the body. When the condition called *uræmia* is present there is but little urea to be found in the urine, yet it would not be advisable to put the patient on an animal diet since such urea as is formed is not readily excreted. When formed by the system, and through any interruption of the eliminating function of the kidney, accumulated in the blood, it is called by some authors, "a powerful irritant poison, rapidly inducing convulsions, coma and death."*

Substances which increase urea in the urine.—Water, common salt, atropine, cubebs, cantharides (in appreciable doses). Copious draughts of water aid in the elimination of urea.

Substances which decrease urea in the urine.—Digitalis, benzoic acid, acetate of soda, phosphate of soda, colchicum, tonics, especially citrate of iron and quinine.

Clinical significance of urea. — The diseases in which urea is *increased* in the urine are:

I. Acute febrile states with emaciation (except yellow fever).

II. Exanthemata.

III. Inflammatory affections.

IV. Some nervous diseases.

V. Diabetes insipidus and mellitus

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*This has been contradicted so far as the poisonous nature of urea is concerned, but the symptoms following accumulation of urea in the system are well-known.

VI. Atrophy from dyspepsia (in children).—athrepsy, Parrot and Robin.

VII. Diffuse bronchial catarrh (without fever).

VIII. Phosphorus poisoning.

The increase of urea in acute febrile disorders, as typhoid fever, continues up to the acme of the attack, reaching anywhere from 50 to 80 grammes for the twenty-four hours; when the fever diminishes there is less metamorphosis of tissue, less "wear and tear," less urea. During convalescence the amount gradually returns to normal.

The above mentioned course is the general rule in the majority of instances; individual exceptions are sometimes noticed.

In intermittents the increase in urea begins *before* the chill; in other words, the *increase in urea shows the coming of the paroxysm before the clinical thermometer can detect any rise in temperature.*

In typhoid fever we find urea enormously increased; Harley cites a case where 78 grammes (1209 grains) were passed in twenty-four hours.

Vogel found the amount in this disease at the height to fluctuate between 40 and 55 grammes (617 to 847 grains); as the fever diminished it fell to 20 grammes (308 grains) to rise to normal with convalescence.

We find urea increased in typhus, remittent fevers, and exanthematous diseases, but not generally to such an extent as in typhoid fever.

In inflammations, as well as in fevers, the amount is increased. A case of croupous pneumonia is cited where the amount of urea on one day reached 80 grammes (1240 grains).

In pneumonia, daily averages of from 40 to 60 grammes (617–925 grains) and even 70 grammes (1080 grains) are found.

The practitioner will do well to remember that

urea is derived from the breaking up of the nitrogenous tissues of the body: that, during the height of acute diseases, this breaking up is abnormally increased, hence the amount of urea is abnormally increased in the urine.

It stands to reason, then, that in such diseases knowledge of the fact that urea is diminishing is, as a general rule, knowledge of the fact that the disease is abating.

After the height of an acute malady has been reached, the amount of urea will often fall below normal, to rise again as convalescence ensues.

When, previous to an acute malady there has been a state of impaired nutrition, or in a fever when there has been much sweating, we must not expect to find remarkable increase of urea.

In pyæmia the amount of urea is greatly increased; 80 grammes (1234 grains) a day have been known.

In many nervous diseases we find the daily amount of urea increased, among which epilepsy—especially during and after the attack—chorea, and progressive muscular atrophy.

In diabetes mellitus 70 grammes (1080 grains) in twenty-four hours have been found, and in insipidus 84 grammes (1296 grains).

Diseases in which Urea is Decreased in the Urine.

I. Long-continued organic diseases.

II. Chlorosis.

III. Paralysis.

IV. Cholera.

V. Yellow fever.

VI. Ovarian tumor and uterine cancer.

VII. Before paroxysms of gout and of asthma.

We find urea *decreased* in amount in the urine of persons suffering from those chronic complaints

"which are accompanied by diminution of the tissue metamorphosis or of the nutrition During intercurrent exacerbations, hectic fever, etc., it is increased again."

A distinction must be made between decrease in urea due to decreased tissue metabolism and that due to inability on the part of the body to get rid of it when formed.

We find urea retained in the body in dropsy and in the condition known as uræmia.

In yellow fever the uræmic condition is found and amazingly small amounts of urea may be voided.

When the kidneys are disordered, urea is decreased, thus we find in Bright's disease a deficiency of this substance in the urine.

We find urea decreased, also, in paralysis, anæmia, chlorosis, ovarian tumor and uterine cancer (Thudichum), Addison's disease (Rosenberg).

In acute yellow atrophy of the liver, the substances known as leucin and tyrosin replace urea in the urine and but little of this last substance is found.

In cholera, urea seems not to be formed in the body (Beale).

The inferences to be drawn from the variations of urea are as follows: the urine of twenty-four hours having been examined, if the acme of a disease from *other* indications seemed to have passed and the amount of urea be still largely in excess, the prognosis is unfavorable; if, however, the amount of urea decreases from day to day the prognosis is favorable.

In Bright's disease, if the amount of urea remains about normal, a more favorable condition is indicated than if the amount be decreased. In any disease, as cholera, where a *diminished* amount of urea has been found, a gradual or rapid increase is a favorable sign.

If for a long time much less urea than normal is passed with the urine, we may have reason to fear that uræmia may result from the retention of urea in the blood (Vogel).

If, in dropsy, diuretics have been given, or for any other reason the kidneys manifest increased activity, the amount of urea will be largely in excess.

The physician must carefully bear in mind the fact that in *strongly ammoniacal* urine part of the urea has been converted into carbonate of ammonium, hence the amount of urea found in such urine "is no criterion of the amount of urea produced."

Detection and Estimation of Sodium Chloride.—Filter the urine, fill a clean test-tube half of it, add two or three drops of nitric acid, and a liberal amount of silver nitrate solution; a heavy white precipitate of a cheesy appearance (silver chloride) soluble in ammonia indicates presence of salt in the urine. In acute diseases the more abundant this precipitate as a rule the more favorable the indication; care must be taken to add always a few drops of nitric acid before adding the silver nitrate as this prevents the precipitation of silver phosphate. If the urine to be tested contain albumin, heat, add a few drops nitric acid, filter and to the filtered urine add silver nitrate. To estimate roughly the *amount* of salt in the urine from day to day collect the urine for twenty-four hours and filling a test-tube exactly half full add two or three drops of nitric acid, then, drop by drop, a solution of silver nitrate (strength 1 in 10) stirring each drop with a glass rod until no further precipitate forms on adding the nitrate. Set the tube aside and on the next day repeat the operation just described, remembering to use a test-tube of the same size as on the preceding day. After the precipitate has settled to the bottom of the tube

it may be compared in bulk with that of the preceding day.

Clinical Significance of Sodium Chloride:

Common salt is a normal constituent of urine, its chemical name being sodium chloride, and its symbol, NaCl, one part sodium and one part chlorine.

According to Vogel the healthy adult passes 10 to 13 grammes *per diem* (154 to 200 grains),

Salt is soluble, therefore never visible in the urine.

The *excretion* of salt depends chiefly upon the activity of the kidneys; the salt excreted comes in the main from salt ingested in food, although if no food be taken, a small amount of salt will be excreted.

Salt is increased in the urine, then, by food in general, especially that containing salt, and by copious draughts of water which dissolves it and aids in its elimination; salt is decreased in the urine by lack of food and of water.

A great decrease in amount of salt or an entire absence of it is of interest to the physician.

Diseases in which Salt is Decreased or Absent:

I. Acute diseases; especially inflammation with exudation.

II. Cholera.

In inflammations attended by exudation, salt may be absent from the urine; for example, in pneumonia when the lung becomes hepatized, salt may be absent for two or three days; resolution occurring, it reappears. When absent from the urine, salt may be found in the sputa (Beale). Salt has a tendency to centre around a point where inflammatory changes are taking place, hence diminished in the urine (Beale).

In acute articular rheumatism, sudden *absence* of chloride with *appearance* of albumin, may indicate a coming attack of pericarditis.

In cholera, salt is greatly diminished; "an increase in salt in the urine during an attack of cholera is a most reliable symptom of recovery." (Buhl).

In inflammatory diseases and in cholera, the physician may obtain aid in making a prognosis by testing the urine for salt; if absent or greatly diminished for any length of time, it is an unfavorable sign.

Diseases in which Salt is Increased in the Urine.

I. Intermittents, during the *chill* and *fever* (twenty-four hours amount *normal*).

II. Progressive muscular atrophy. (Bamberger).

The following summary of Vogel is of interest:

"In all acute diseases a *progressive diminution* of salt shows an *increase*, and a *progressive increase* of salt a *diminution* of the disease; if the amount fall below 0.8 gramme daily, we conclude that there is considerable intensity of the disease."

In chronic diseases the amount of salt is a tolerably accurate measure of the digestive power of the patient; an abundant amount (10 to 16 grammes daily) permits us to infer that digestion is good, a small amount (below 8 grammes) shows a weak digestion, provided there are no watery dejections or any other moderate exudation.

Detection of Sulphates.—Fill a clean test-tube half full of urine, add a few drops of hydrochloric acid then some solution of barium chloride; a white precipitate, which is not dissolved on further addition of nitric acid, indicates presence of sulphates.

Clinical Significance of Sulphates.

Normal urine contains sulphuric acid, in daily amount averaging from 1½ to 2½ grammes, and in combination with sodium and potassium forming the sulphates of the latter. The ingestion of sulphur, sulphides, or sulphates contained in articles

of diet will increase the amount of sulphates in the urine but, under no circumstances, is there ever a deposit of them. The clinical significance, if any, of the sulphates is but imperfectly understood; if their amount increase in *acute febrile* disorders when *little or no food is taken*, decomposition of the elements of the body is indicated.

The sulphates are *increased* in:

(1) Progressive muscular atrophy. (Bamberger).

(2) Phosphorus-poisoning. (Cazeneuve).

(3) Diseases of the brain. (Bence Jones).

The sulphates are *decreased* in:

(1) Chronic renal disease. (Heller).

(2) Carbolic acid poisoning. (Baumann).

Detection of Phosphates.—If the urine be clear, containing no sediment, and of acid reaction, fill a test-tube half full of it, add ammonia and heat. A flocculent precipitate appearing indicates presence of *earthy phosphates*; filter the urine and to the filtrate add solutions of ammonium carbonate and magnesium sulphate. White flocculent precipitate indicates presence of *alkaline* phosphates. (When the *earthy phosphates* form a sediment or deposit proceed as under Deposits; the methods just mentioned are merely given to enable the physician to tell whether a given specimen of urine contains phosphates in fair amount or not).

Estimation of Phosphates.—In most cases a study of the variations in amount of the earthy phosphates will be a sufficient clinical guide.

Obtain a specimen of normal urine—preferably a sample of the mixed urine of twenty-four hours—and after filtering it place 10 Cubic centimetres into a tube or glass jar and add to it 5 Cubic centimetres of ammonia. Agitate thoroughly as before and allow the mixture to rest. The next day observe the

height of the precipitate in the tube; if the latter be graduated, say into fifths of a Cubic centimetre, the accuracy of the operation will be greatly increased. Having thus observed how heavy a precipitate forms in the normal urine, apply the same method of procedure to a specimen of supposed abnormal, and a great excess of earthy phosphates in the latter will be indicated by a great comparative height of the precipitate in the tube. To obtain satisfactory results, a specimen of the urine of twenty-four hours should, in each case, be used; for instance, suppose the normal urine used were that passed after drinking three or four glasses of water, and the abnormal that passed on rising in the morning—to draw any conclusions from the comparison of two such widely differing specimens would be absurd. For further consideration of phosphates see Deposits.

The amount of phosphoric acid, which in combination with potassium, sodium, calcium and magnesium, is passed daily in the urine averages from 2.5 grammes to 3 grammes daily (38 to 46 grains). Two-thirds of this amount is contained in the phosphates of sodium and potassium (alkaline phosphates), and the remainder in the earthy phosphates, i. e., those of calcium and magnesium.

It has been customary to attach considerable importance to a deposit of earthy phosphates—which will occur when the urine becomes alkaline. (see Deposits)—whereas from the very reason that deposits of these substances depend upon an alkaline condition of the urine they rarely have a grave import, except when composed of the triple phosphate.

Persistent excessive elimination of phosphoric acid with or without deposition of the earthy phosphates. is generally associated with grave constitutional disturbances. (Ralfe.)

Diet which may Increase the Amount of Phosphates in the Urine:

Beef, bread, potatoes, milk.

Diet which may Decrease the Amount of Phosphates:

Starchy, saccharine, and oleaginous foods.

Diseases in which the Total Amount of Phosphates may be Increased:

I. Inflammatory diseases of the nervous system; nerve lesions in general—injuries to the head.

II. Acute febrile disorders (not invariably).

III. Bright's disease and cholera (if obstruction be removed by which they have been retained).

IV. Phosphorus-poisoning.

[In rachitis, according to Seeman, phosphates actually *diminished* in the urine].

Diseases in which the Total Amount of Phosphates may be Decreased:

I. Renal and intestinal diseases. (Brattler).

II. Intermittent fever, during the interval. (Haxthausen).

III. Chronic diseases of the brain, exhaustion stage of mania, acute dementia, delirium tremens.

IV. Severe pneumonia.

V. Gout and arthritis deformans.

(An increase in the amount of phosphates in *these* diseases is therefore favorable).

Diseases in which the EarthyPhosphates may be Especially Increased in the Urine:

I. Mollities ossium.

II. After severe burns.

III. Nervous exhaustion from severe study and loss of sleep.

IV. Diabetes.

V. Tertiary syphilis.

VI. Cerebral and spinal tumors; osseous tumors.

VII. Cancer.

VIII. Caries.

IX. Meningitis.

X. Progressive muscular atrophy, (magnesium phosphate chiefly).

The physician must carefully bear in mind the fact that when urine is *acid* in reaction, it may contain an excessive amount of phosphates and yet contain no deposit; nor is a deposit of them necessarily a sign of excessive amount, since *alkalinity* of the urine will cause them to appear even when not in excessive amount.

When we have to deal with the persistent elimination of phosphoric acid in excessive quantities very distressing constitutional symptoms are associated with its discharge. The symptoms vary considerably in individual cases, but they are all more or less characterized by great nervous irritability, derangements of digestion, great emaciation, severe aching pains in the back and loins, especially affecting the pelvic viscera. (Ralfe). When these symptoms are present and the urine is copious, of acid reaction and clear, an estimation of the quantity of phosphoric acid may throw new light on an otherwise doubtful case.

When it is remembered that persistent elimination of phosphoric acid is sometimes a forerunner of diabetes, especially insipidus, the importance of an early recognition of the condition may well be comprehended.*

Increased amount of phosphates in the urine is often associated with troublesome eye affections; it is also found in connection with tardy reparation of wounds and is likely to render bones more fragile, causing fractures and tardy union. The physician, therefore, should not plume himself on the fact that

*A disease known as "phosphatic diabetes" is sometimes observed.

as the urine is clear and free from deposit it is therefore clinically meaningless, until he has proved that the phosphates are not persistently in great excess. When the urine is *alkaline* and "whey colored" from a heavy deposit, the attention of both patient and practitioner will naturally be called to it. See Deposits.

Detection of Urates.—This may be accomplished by adding to ten parts of urine one part of hydrochloric acid. Allow the mixture to stand thirty hours in a cool place when crystals of uric acid will form, recognized by the naked eye or by the microscope. See Uric acid Deposits.

Clinical Significance of Urates:

Uric acid in combination with sodium, potassium, ammonium, or (rarely) calcium, forming the urates of sodium, potassium, etc., is a normal constituent of urine. About $1\frac{3}{4}$ grammes of urates (27 grains) are voided daily.

Diet which may Increase the Amount of Urates:

Nitrogenous foods: lean meat, etc. Port wine, beer.

In other words, "high living" is often responsible for an increased amount of these substances.

If the urine is not too acid in reaction it may carry an increased amount of urates without showing a deposit of them; in such cases the specific gravity will be comparatively high, 1020 or 1025. To estimate the amount of uric acid passed daily in combination with its bases is not at all convenient for the physician. For further consideration see Deposits.

Increase but not Necessarily Deposit of Urates in Disease.

The advice of Coignard in regard to uric acid in the urine is worth remembering: "in a large number of persons no actual disease can be demonstrated

but they are constantly ailing, are more irritable than their fellows, especially if their hygienic surroundings are bad, their life idle or their occupations sedentary. In such cases it is necessary to estimate the amount of uric acid combined and forming urates, and if there be excess, correct the diet, give them plenty of exercise and a methodical alkaline treatment."

According to Ralfe, uric acid is eliminated in excess, (i. e., in combination with urates) but not necessarily deposited from the urine under two conditions:

1. Uric acid in excess usually attended by a diminution of the other urinary constituents, (true lithæmia); this occurs chiefly in diseases of the liver, such as acute yellow atrophy, cirrhosis, and cancer. In scurvy an excess of uric acid is generally observed with a diminution of urea and the alkaline phosphates.

2. Uric acid in excess attended by an increase of the other urinary constituents; this may occur in functional derangements of the liver, especially those brought about by disturbance of the "nitrogenous equilibrium," by the ingestion of too much animal food. It may happen as a condition antecedent to the development of phthisis or cancer and sometimes diabetes, or preceding the outbreak of such constitutional conditions as syphilis, scrofula, and of gout in its early attacks.

In order to ascertain whether uric acid is in excess, its amount must be estimated, i. e., the total amount combined with sodium, potassium, etc., forming the urates.

Dr. E. A. Cook (*British Med. Journal*, April 15, 1882), gives a method for approximately estimating the amount of uric acid in normal urine and the results of his process go to show that the normal

amount of uric acid excreted by a healthy adult is much greater than has hitherto been supposed; not less than ten grains and seldom less than twelve grains being the quantity discharged in twenty-four hours. His method is the following: take 300 or 400 Cubic centimetres of the urine, and add a few drops of strong solution of caustic soda, enough to render it decidedly alkaline; allow the precipitate of phosphates to subside and pour off 100 Cubic centimetres of the clear solution; add to this clear solution about 4 Cubic centimetres of a solution of zinc sulphate, 1 to 3 strength. The solution of zinc sulphate renders blue litmus red, and it must be added to the urine until a drop of the mixture on blue litmus gives a slightly red circle. If the solution be too acid, a drop or two of caustic soda solution will render it neutral. The precipitate is thrown on a filter, and washed with a saturated solution of zinc urate. This solution is made by adding a little zinc sulphate to distilled water, and then adding urate of soda until a permanent precipitate remains; this precipitate is allowed to subside, and the solution is used for washing until all urea and ammonia are removed. The drained precipitate is folded in the filter and placed with 50 Cubic centimetres of hypobromite of sodium of full strength in an urea estimation apparatus, and agitated carefully. The gas evolved will be an indication of the amount of uric acid present in 100 cubic centimetres of the urine, inasmuch as 8 Cubic centimetres of nitrogen gas at 60° F., and 30 in barometer are evolved from 10 Cubic centimetres of a solution of sodium urate, (containing 648 grammes of uric acid in 100 cubic centimetres) plus 90 cubic centimetres of water. The reaction is complete at the end of half an hour without the application of heat.

The practitioner will guard against confusion in

the use of the terms "uric acid" and "urates" by remembering that urates are a combination of uric acid with sodium, etc., and it is customary to estimate the amount of this uric acid, which is in combination, and to speak often of urine containing so much "uric acid," meaning simply the amount of uric acid in combination with the sodium, etc., forming urates. *Uncombined* uric acid is normally present only in a very small amount; when plenteous it forms a sediment.

Detection of Coloring Matter.—(1) Fill a clean test-tube half full of urine, and allow twenty or thirty drops of nitric acid to trickle down the sides of the tube into the urine; when the acid and urine meet a zone of light pinkish-red color will be observed, indicating presence of *urohematin.* The darker the zone the more the urohematin. The color is best observed by holding against a white object. (2.) Fill a clean test-tube half full of urine and allow twenty or thirty drops of pure hydrochloric acid to trickle down its sides. Where the urine and acid meet a zone of violet color, gradually developing itself, indicates presence of *indican;* the more the the indican the bluer the color of the zone.

Determination of Urinary Coloring Matter.—Vogel's table of colors gives results sufficiently accurate for clinical purposes; filter the urine, pour it in to a glass jar of not less than 4 or 5 inches diameter, and observe what color in Vogel's scale it nearest corresponds to. (Books of colored papers representing the colors of Vogel's scale can be had of dealers in chemical apparatus and of many surgical instrument makers.)

After having ascertained the color of the urine consult the following table:

I	II	III	IV	V	VI	VII	VIII	IX	
1	2	4	8	16	32	64	128	256	Pale Yellow=I
	1	2	4	8	16	32	64	128	Light " =II
		1	2	4	8	16	32	64	Yellow =III
			1	2	4	8	16	32	R'ddish " =IV
				1	2	4	8	16	Yell'ish Red=V
					1	2	4	8	Red =VI
						1	2	4	Brownish " =VII
							1	2	R'd'sh Br'wn=VIII
								1	Brownish Bl'k=IX

Form a proportion as follows:

1000 : the number corresponding to the color of the urine :: the quantity for 24 hours : x.

If the urine is yellow look under III and we find the first figure to be 4; therefore 1000 : 4 :: quantity for 24 hours : x. Suppose in 24 hours 1800 Cubic centimetres of urine were passed, then 1000 : 4 :: 1800 : x, or x=7.2 parts coloring matter in 1800 Cubic centimetres yellow urine.

Creatinin and Hippuric Acid.

The urine of twenty-four hours normally contains 5 or 10 grains of creatinin; it is of no clinical significance.

Hippuric acid is increased by the eating of much fruit, especially prunes, mulberries and bilberries, and by the ingestion of the balsams of Peru and tolu and benzoic acid.

CLINICAL SUMMARY.

(NORMAL CONSTITUENTS.)

Urea is *increased* in acute febrile states and in diabetes; it is *decreased* in Bright's disease and in long-continued organic diseases in general.

Sodium Chloride is *decreased* (sometimes absent)

in acute diseases, especially inflammations attended by exudations, as pneumonia.

The Sulphates are of little clinical importance.

The Phosphates may be *increased* in inflammatory diseases of the nervous system and in cases of nerve lesions in general; also in certain cases of diabetes. They may be *decreased* in Bright's disease.—Brattler.

The Urates are similar in significance, when not found as a deposit, to urea.

Urohematin is *increased* in acute febrile disorders and often in diabetes; it is diminished usually in anæmia and chlorosis.

Indican may be increased in the urine of persons far advanced in phthisis, or suffering from cancer.

CHAPTER V.

URINARY CALCULI.

The chemical elements in calculi are the same as those in deposits.

Method of Procedure in Examining Calculi:

Reduce calculus to powder in agate mortar.

Place some of this upon platinum foil.

Heat in the flame of an alcohol lamp to a red heat.

If the heating is accompanied by a flame the calculus contains either: (*a*) fatty matters, (*b*) cholesterin, or (*c*) cystin.

Take some of the powdered calculus which has not been heated and treat it with ether; if it dissolves, *fatty matters and cholesterin* are indicated; if it does not dissolve, take a fresh amount and add ammonia to it; if it dissolves, *cystin* is indicated. Moreover, the odor of cystin is nauseous, and its flame is bluish-green in color. Suppose now the heating of some of the powdered calculus was not accompanied by a flame, then the calculus consists of one more of the following:

Uric acid,	Calcium phosphate,
Ammonium urate,	Ammonio-magnesium phosphate,
Sodium urate,	Calcium oxalate,
Calcium urate,	Xanthin,
Magnesium urate,	Fibrin.

To distinguish the members of the above list observe when heating to calcination whether (*a*) *no residue* is left, (*b*) a *slight* residue, or (*c*) *considerable* residue. Calculi which, on being calcined, leave no residue are either

Uric acid,	Xanthin or
Ammonium urate,	Fibrin.

Uric acid and ammonium urate calculi are distinguished from the two others by the murexid test; take a fresh amount of the calculus which has not been heated, place it on porcelain, add a little strong nitric acid, heat gently until evaporation, let cool, add ammonia. Magnificent red color indicates presence of uric acid or urates.

If the murexid test, carefully performed, gives no results, take a fresh amount of the calculus and add solution of potassium carbonate; if it dissolves, xanthin is indicated; if it does not dissolve, test for fibrin which is soluble in caustic potash solution, has an odor of burnt horn and is precipitated from solutions by potassium ferrocyanide.

Those calculi which leave a *slight* residue on incineration are urates of sodium, calcium and magnesium, and may be recognized by the murexid test.

Those calculi which leave a *considerable* residue on incineration are calcium oxalate, calcium phosphate, ammonio-magnesium phosphate.

If the calculus is calcium oxalate, a small portion of it will not dissolve in acetic acid; effervescence takes place when a drop of nitric acid is poured on a little of the residue after ignition.

Calculi of ammonio-magnesium phosphate and calcium phosphate ordinarily occur together and may be recognized by melting to a white enamel-like mass on incineration; hence a calculus composed of these two substances is called a *fusible* calculus.

Observations.

Calculi do not always consist of some one or two constituents, sometimes they contain several, hence before proceeding to examination of a calculus it is advisable to saw it in two through the centre with a jeweler's saw and notice whether it is built up of distinct layers or apparently consists of one substance.

If the former is the case, carefully scrape off portions of each layer and examine them separately. If the calculus is in fragments, select fair specimens of about half a grain or a grain each and crush under the blade of a knife.

Most calculi have a nucleus which is sometimes a foreign body upon which the urinary sediments deposit and form a crust. Retained gravel may also become the nucleus of a calculus, in which case the nucleus will be likely to differ from the rest of the calculus in chemical composition. Sometimes the calculus has a vacant space in its interior; in this case the nucleus consisted of mucus which later became dry. In rare cases the nucleus rattles within the stone, which is to be explained in the same way, by the drying up of the mucus. Sometimes the calculus is made up of gravel or several small stones which are united by a cement, and which sometimes have the same chemical composition as the calculus and sometimes a different one.—Vogel.

To make a thorough and systematic examination af urinary calculi one has need of a jeweler's saw and agate mortar, platinum foil, several watch glasses, an alcohol lamp and a good knife with small, sharp blades, together with various reagents.

An approximate idea of the most important calculi may be gained from the following:

Uric Acid calculi are relatively very common and may reach a very considerable size. They are usually yellowish, reddish, or red-brown, rarely white, and generally have a smooth surface and are tolerably hard.

Phosphatic calculi may be of considerable size; they usually have a whitish color and are soft, porous and chalky or denser and harder according to the particular phosphate which predominates in them.

Oxalate of Lime calculi are tolerably frequent, especially in children. They are either small, pale, and smooth—*hemp seed calculi*—or are larger, of rough exterior, tuberculated, warty and colored on the surface, usually dark brownish or even blackish —*mulberry calculi.*

Carbonate of Lime calculi are rare but are easily detected by the property of dissolving with effervescence in hydrochloric acid.

CHAPTER VI.

WHAT TO LOOK FOR IN THE URINE OF DISEASE AND HOW TO DO IT.

If the urine contains *albumin*, look with the microscope for tube casts and other evidences of kidney disease. Measure the amount of twenty-four hours' urine. If the urine contains a *small amount* of albumin, it is well to be on one's guard lest *pus* or *blood* should be overlooked. In *albuminous* urine the sediment will often contain *fungi;* these should not be mistaken for blood-corpuscles. If the urine be pale, of *high specific gravity* and sweetish odor, test for *sugar*.

When a *large quantity* of urine is passed daily, containing no sugar, estimate the solids so as to recognize diabetes insipidus, if present. In acute febrile disturbances estimate the amount of *urea* from day to day, and examine deposit for *urates* in large amount; in inflammations attended by exudation, watch the *chlorides;* albumin is often found in these conditions and if the kidneys become involved, casts, cells, etc., and in severe cases, blood and pus corpuscles.

The re-appearance or increase of *chlorides* in an acute inflammation is deemed favorable; the appearance of albumin unfavorable.

Among many acute febrile processes there are certain ones where examination of the urine is of especial value; these are:

I. Icterus.

II. Acute atrophy of the liver.

III. Acute lung diseases.

IV. Heart diseases.

V. Peritonitis.

VI. Meningitis.

VII. Acute articular rheumatism.

I.

In Icterus look for biliary *coloring matters* in the urine; whether found or not, next examine the urine for *albumin.* If *albumin* be present, the case is one of *icterus gravis* and small amounts of biliary acids may be detected.

II.

In Acute Liver Atrophy look for *leucin* and *tyrosin*, epithelial casts, fibrinous cylinders, kidney epithelium and isolated blood-corpuscles in the sediment; examine also for albumin which is generally very abundant. Test for the chlorides which generally are absent. Urates and biliary matters will also be present.

III.

In Acute Lung Diseases the larger the amount of *urates* the more insufficient the respiration.

IV.

In Heart Diseases test for *albumin.*

V.

In Peritonitis look for increase of *indican.* (Senator.)

VI.

In Meningitis observe whether the specific gravity is high and whether, on boiling the urine the *earthy phosphates* separate. (In typhus the earthy phosphates do not thus appear). The differential diagnosis between typhus and meningitis cannot invariably be determined as above.

VII.

In Acute Articular Rheumatism expect to find the *earthy phosphates* much increased; the sediment should contain rose-red urates and oxalate of lime

colored by uroerythrin; if *pericarditis* be dreaded or exist, estimate the *chlorides* often. The earthy phosphates will decrease with the chlorides on advent of pericarditis, but the uroerythrin will appear still more beautiful.

In Non-Febrile Diseases and in *chronic* diseases for the most part, observe that the *color* of the urine is not dark reddish-yellow and *urates* are not present in large amount.

Among these affections the following possess certain characteristic peculiarities:

I. Chlorosis.

II. Hysteria.

III. Diabetes mellitus.

IV. Chronic diseases of the spinal cord.

V. Rachitis and osteomalacia.

VI. Bone diseases involving a great part of the skeleton.

VII. Chronic articular rheumatism.

VIII. Gout.

IX. Intermittent fever.

X. Chronic liver affections.

XI. Chronic skin diseases.

XII. Scurvy and purpura hæmorrhagica.

XIII. Melanæmia.

XIV. Leucæmia.

I.

Chlorosis shows a very pale urine of low specific gravity.

II.

Hysteria is like chlorosis, but at times the specific gravity is greater and a large amount of *indican* present.

III.

In Diabetes Mellitus test the urine for *albumin* which appears in considerable quantity in the later

stages of the disease. In the sediment look for *fungi.*

IV.

In Chronic Diseases of the Spinal Cord test for increased *indican* and *earthy phosphates.*

V.

In Rachitis and especially in *osteomalacia* some authors claim the *earthy phosphates* to be strongly increased and to form a copious sediment.

VI.

In Bone Diseases involving a great part of the skeleton, expect to find increase of *carbonate* and *oxalate* of lime in the sediment and increase of *earthy phosphates* partly in solution and partly in sediment.

VII.

In Chronic Articular Rheumatism expect to find a sediment rich in *urates* and *calcium oxalate;* also a great increase of *earthy phosphates.*

VIII.

In Gout estimate the *uric acid* which is generally excreted in diminished amount; at times *free uric acid* is found in the sediment.

IX.

In Intermittent Fever during the *cold stage* an increased amount of light, clear urine is voided.

X.

In Chronic Liver Affections, even when no fever exists, the urine may be dark, acid, and of high specific gravity and diminished quantity.

Coloring matters are increased; in the sediment observe rose-red urates and often small amount of lime oxalate.

XI.

In Chronic Skin Diseases, especially if the function of perspiration is partly destroyed, test the urine for *albumin* and examine the deposit for evidences of kidney complications.

XII.—XIII.

In Scurvy and Purpura Hæmorrhagica test for blood in the urine; also in *melanœmia.*

XIV.

In Leucæmia look for *uric, hippuric* and *lactic acids.*

Examination of the Urine in Kidney Diseases.—The chief points to be observed in these disorders are the quantity of urine in twenty-four hours, the color, the specific gravity, the amount of albumin, the amount of urea, and in fact the total amount of solids. In pregnancy collect as often as possible the urine of twenty-four hours; bear in mind the fact that a gradual falling off in the twenty-four hour quantity is suspicious. It may lead to a sudden and marked decrease, uræmia and convulsions. [For further particulars regarding the urine in kidney diseases, see the author's new work on "Diagnosis of Kidney Diseases, etc."]

What to do in Diabetes Mellitus.—Estimate the quantity of sugar from time to time, and be on your guard against diabetic coma. Observe carefully any chloroform odor. [The chloroform odor of many diabetic urines is said to be due to the *acetone* which they contain; such urines are colored dark reddish-brown with ferric chloride. (Kussmaul affirmed that diabetic coma was due to acetone in the blood; but in several cases competent observers have found none, and in others, only faint traces.)

The substance in the urine of diabetics which gives a red coloration with ferric chloride, resembles in this respect acetic ether; it also breaks up into acetone and alcohol. Nevertheless, Quincke has shown that urine giving this reaction with ferric chloride does not smell of acetic ether, nor can the latter be extracted from the urine by shaking with ether, and, if in combination, is neither with acids, alkalies nor normal constituents.

Deichmueller failed to obtain any alcohol from forty litres of diabetic urine, but found from .093 to .147 per cent. of acetone. He concludes that the substance giving the red coloration with ferric chloride is free diacetic acid. Tollens confirms this, and adds that when such diabetic urine is shaken with ether there is only a trace of the ferric chloride reaction with the ether extract; but when a solution of ethyl-aceto-acetate was added to the urine in proper proportions, the latter was readily extracted by ether.]

Whatever the substance may be it is certain that of late, many well-known and even celebrated men, attended by physicians of ability, have died suddenly, and almost without any hint of danger being given, diabetes being recognized but a few days before death. (See "Diagnosis of Kidney Diseases.")

HOW TO EXAMINE URINE.

It is well to observe methodically a certain order in the chemical and microscopical examination of urine. Proceed as follows:

I. Observe physical characteristics, color, odor, specific gravity, etc., etc.

II. Pour off half the urine and let the other half settle. Test the first half for albumin, bile, sugar, peptone. In testing for albumin, an idea of the presence or absence of bile can be had from the color zone with nitric acid. If albumin be found, boil well and filter before testing for sugar. If albumin or sugar be found, estimate the quantity.

III. Examine the urine for the normal constituents, urea, sodium chloride, etc., estimating the quantity.

IV. Lastly, examine the sediment in the other half of the urine which has been allowed to settle while processes I.–III. are being performed. Use both chemical and microscopical means.

V. Study the clinical significance of results obtained, and by all means take into consideration various modifying circumstances due to diet, climate, or drugs. Remember that it is almost essential to have urine of twenty-four hours to work on. Bear in mind the failure which has usually attended all processes, however conscientiously performed, designed to manufacture a silk purse out of a sow's ear, and therefore refuse to make a diagnosis from examination of a thimbleful of urine. In supposed kidney diseases the quantity in twenty-four hours, amount of albumin, and percentage of urea are the important factors in the diagnosis, which should not be made

from one or two hurried and desultory examinations of hit-or-miss urine passed at an unknown hour in the day, possibly after drinking large quantities of water or worse. Remember that albumin and casts do not NECESSARILY mean fatal Bright's disease; remember that albumin in the urine of a pregnant woman does not NECESSARILY mean convulsions; but, when the above conditions are found, remember that it is highly necessary to understand what they *do* mean.

VI. Bear in mind in the course of chemical work the effect of reagents, etc., on normal urine, as follows:

Boil normal urine and it should be clear.

Acids (concentrated) added to the urine generate, on boiling the same, a peculiar, nauseous odor and the urine becomes more or less dark.

Alkalies produce a cloudiness in the urine caused by precipitation of phosphates (earthy).

Barium chloride solution added to urine acidified with hydrochloric acid precipitates the sulphuric acid of the urine in the form of barium sulphate.

Silver nitrate solution, added to urine, precipitates the phosphates and chlorides as silver phosphate and silver chloride; if nitric acid be added to urine and then silver nitrate solution, silver chloride alone is precipitated.

Ferric chloride solution precipitates the phosphoric acid, if acetic acid has first been added.

Lead acetate solution precipitates the chlorides, sulphates and phosphates as lead salts; it is useful, therefore, when we desire for purposes of analysis to free the urine from these constituents.

Oxalic acid or oxalate of ammonium precipitates the lime of the urine as lime oxalate.

Mercuric nitrate produces in urine, from which the sulphuric and phosphoric acids have been

removed, a cloudiness which disappears; further addition, now, of mercuric nitrate causes a white, insoluble compound of mercuric oxide and urea to separate.

Alcohol produces a cloudiness which disappears on dilution with water.

VII. Remember that if the urine is stale, allowance must be made for certain conditions.

After standing some time normal urine begins to change, fermentation, so-called, begins, due, according to Scherer, to decomposition of mucus from the bladder, forming a fungus very like the ferment Mycodermæ Cerevisiæ, and then the coloring matter decomposes:

In consequence of this the color of the urine usually grows paler, the reaction more acid, due to the fermentation of lactic and acetic acids; a sediment forms, red in color, consisting of uric acid, urates and mucus. These are the phenomena of so-called *acid* fermentation, but further on in process of time the so-called *alkaline* fermentation may set in—in some cases this may happen before and without acid fermentation—in which the urea of the urine is decomposed into acid ammonium carbonate and free ammonia; the urine acquires a strong ammoniacal odor and effervesces strongly on addition of acids. The sediment will now contain triple phosphate crystals, and, with the microscope, fungous threads, infusoria, and ammonium urate may be seen. Alkalies added to the urine in this stage cause an abundant generation of ammonia.

FORWARDING URINE FOR EXAMINATION.

It very often happens that in puzzling cases the general practitioner may desire to forward samples of urine to some one making a specialty of urinary analysis, etc.

Much time and trouble may be saved by observing the following particulars:

1. Collect and measure—if a possible thing—the urine of 24 hours and inform the person to whom the urine is forwarded what the quantity is.

2. Forward at least a pint if possible of the mixed urine of 24 hours.

3. The bottle containing the urine should be tightly corked, sealed, wrapped in cork-paper, packed in straw, and sent in a box by express. A letter should be sent beforehand, if possible, notifying the person to whom the urine is to be sent. The person receiving the urine can then arrange for prompt examination of the specimen, which might otherwise have to wait its turn.

4. In very hot weather a little chloral hydrate may be added to the urine as an antiseptic; if so, the person receiving the urine should be notified of the addition.

BEDSIDE TESTING.

Attempts have been made from time to time to put chemical reagents into such form as will admit of use in the sick room without disagreeable attendant circumstances. For example, instead of the corrosive liquid nitric acid, glacial phosphoric acid has been used which comes in the form of cakes; breaking off a fragment and dropping it into the urine causes a turbidity to be seen, if albumin is present. Trichloracetic acid has also been used for the same purpose as it is crystalline in form. Dr. Pavy prepared test pellets for use in sugar testing. Dr. Oliver devised a set of test papers impregnated with various chemical substances by use of which albumin and sugar are detected at the bedside. Without discussing the merits and demerits of the various bedside methods of testing, I desire to call the attention of the profession to an ingenious urine test case devised for me by Dr. F. O. Pease, and which I carry in my pocket when at a distance from my office or laboratory. It contains litmus paper, specific gravity beads, Vogel's color scale, filter paper, a candle and support, two test-tubes, a vial containing citric acid pellets, one containing caustic potash in stick form. The reaction of the urine can be taken at the bedside by means of the litmus paper, which is of the kind that turns blue with alkalies and red with acids; the specific gravity can be ascertained by means of the glass specific gravity beads, the color compared with the colors on Vogel's color scale, the urine filtered by setting the filter paper into the wider-mouthed test-tube, tested for

albumin by means of a citric acid pellet and heat of the candle-flame (tube held on edge of flame to avoid smoking), tested for sugar with the caustic potash, as also for bile by the stain on the filter paper. Any sediment in the urine can be tested for urates by heating in the candle-flame, for phosphates by a citric acid pellet, for pus with the caustic potash, for blood by the caustic potash and heat, etc., etc. I have had directions for its use published, as many have expressed a desire to make use of the case in their daily practice.

GLOSSARY.

Albuminuria.—Voiding of urine containing albumin; this term is used by some authors to mean Bright's disease.

Albuminoid Substances.—Those resembling albumin, as mucin, fibrin, etc. Protein substances.

Baruria.—The passing of urine containing increased amount of solid matters only.

Bilharzia Hæmatobia.—Name of a parasite sometimes found in the intestines, bladder, etc., of persons living in certain hot climates.

"Brick-Dust" Sediments.—Those containing in large part uric acid or urates.

Calculus.—Stone in the bladder. *Calculi*, plural of calculus.

Chyluria.—Voiding of urine containing chyle.

Diuresis.—Profuse discharge of the urine.

Diuretics.—Substances increasing the flow of urine.

"Dry" Tests for Albumin, Etc.—Those in which the chemicals used are in the solid form.

Dysuria.—Painful, difficult voiding of urine.

Echinococcus Hominis. — Hydatids sometimes found in the urine from cysts formed in kidneys or vicinity of urinary apparatus.

Enuresis.—Incontinence of urine.

Extractive Matters.—Imperfectly defined substances pre-existing in the blood and occasionally found in the urine.

Fermentation.—Decomposition of urine; two kinds are recognized, namely, acid and alkaline.

Glycosuria.—Voiding of urine containing sugar; the term is sometimes used by authors to mean diabetes mellitus.

Glucose.—Sugar of grapes, etc.: used to mean the sugar found in urine.

Gravel.—Minute calculi.

Hydruria.—Voiding of urine containing increased quantity of water only.

Kiestein.—Name given to a "scum on the surface of urine during its putrefaction." Thought at one time to be of diagnostic significance in pregnancy.

Lateritious.—An adjective used to describe "brick-dust" sediments and urine containing them. Thus, a lateritious sediment is a sediment looking like "brick-dust." Lateritious urine is that containing a "brick-dust" sediment.

Leucocytes.—General term for white blood corpuscles, mucus or pus corpuscles.

Lithic Acid and Lithates.—Old terms for uric acid and urates.

Lithæmia.—State of the system when uric acid is eliminated in excess but usually with a diminution of the other urinary constituents: the term is also used in general to describe a condition when uric acid is in excess in the urine.

Lithuria.—Voiding of urine containing increased uric acid.

Melanin.—Black pigmentary matter.

Mucin.—The principal organic constituent of mucus.

Mulberry Calculus.—One composed of oxalate of lime.

Oxaluria.—Voiding of urine depositing oxalate of lime.

Polyuria.—Voiding of urine containing increased water and solids.

Xanthuria.—Voiding of urine depositing xanthin.

END.

INDEX.

CATALOGUE

OF

Homœopathic Publications

OF

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